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Ollinger, IV et al.

(54) **WEAR ASSEMBLY FOR EXCAVATING EQUIPMENT**

(75) Inventors: **Charles G Ollinger, IV**, Portland, OR (US); **Chris D Snyder**, Portland, OR (US); **John S Kreitzberg**, Portland, OR (US)

(73) Assignee: **ESCO Corporation**, Portland, OR (US)

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(22) Filed: **Oct. 5, 2011**

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(60) Provisional application No. 60/928,780, filed on May 10, 2007, provisional application No. 60/928,821, filed on May 10, 2007, provisional application No. 60/930,483, filed on May 15, 2007.

(51) **Int. Cl.**
E02F 9/28 (2006.01)

(52) **U.S. Cl.**
USPC **37/453**

(58) **Field of Classification Search**
USPC 37/446, 452–460; 172/772, 772.5, 749, 172/705, 713; 403/379.2, 379.4
See application file for complete search history.

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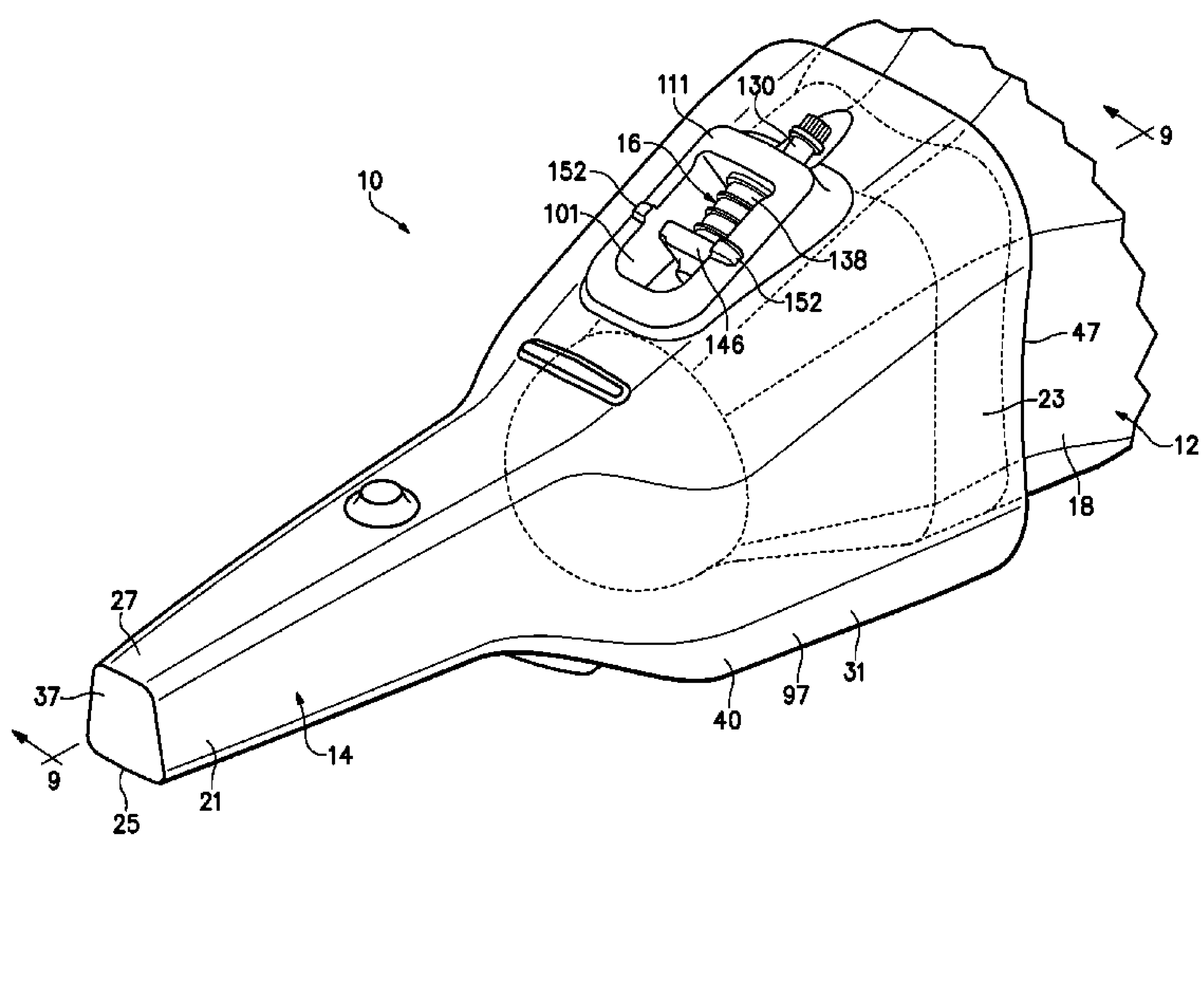
Primary Examiner — Robert Pezzuto
(74) *Attorney, Agent, or Firm* — Steven P. Schad

(57) **ABSTRACT**

A wear assembly for excavating equipment includes a base fixed to the excavating equipment, a wear member fit over the base, and a lock to releasably hold the wear member to the base. The wear member includes side relief to reduce drag on the system. The wear member and the base each includes a hemispherical front end and a generally trapezoidal rear portion. The base includes a nose and a stop projecting from the nose to cooperate with the lock without an opening being needed to receive the lock into the nose. The lock is an elongate lock positioned generally in an axial direction and which holds the wear member to the base under compressive loads.

34 Claims, 13 Drawing Sheets



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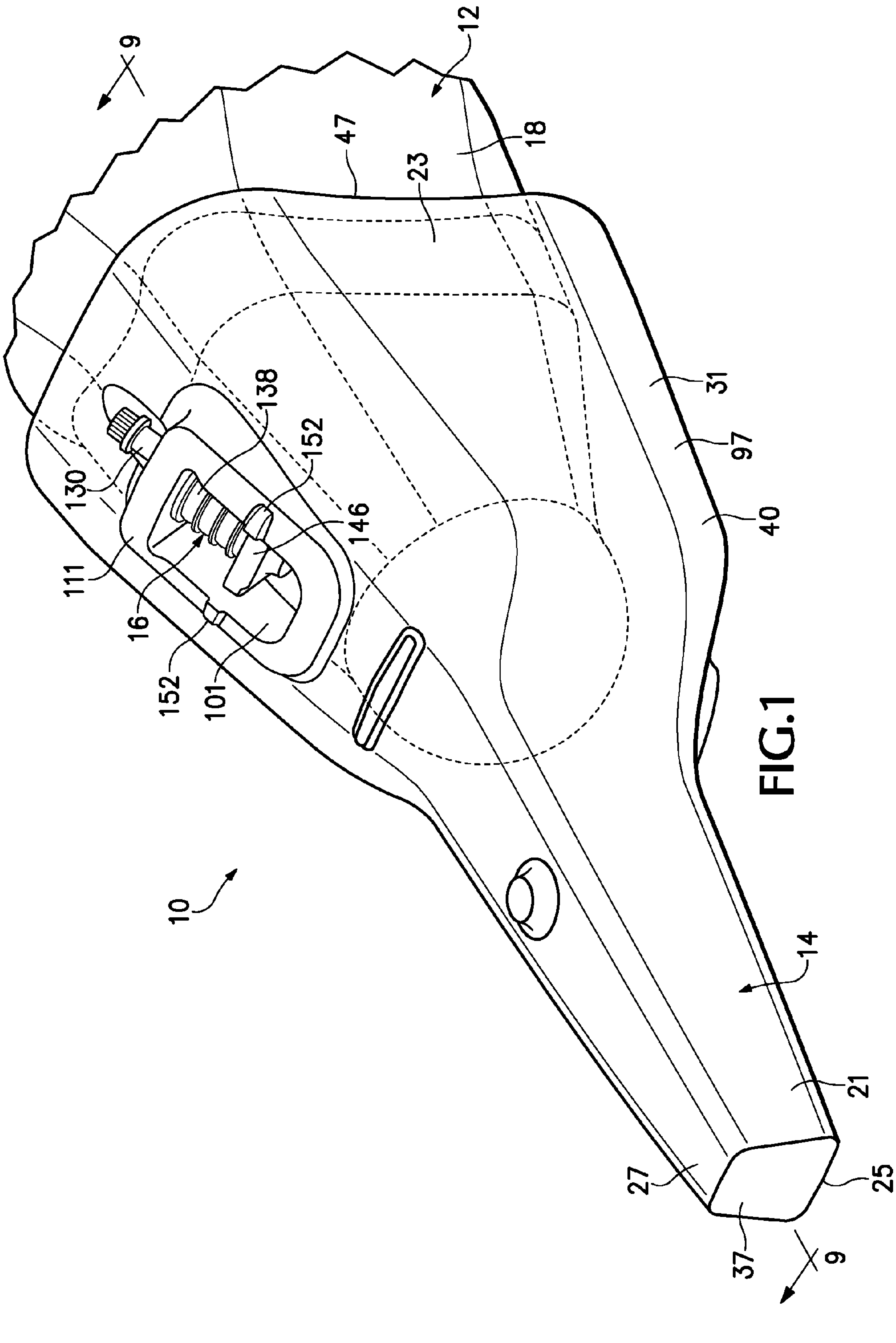
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FIG.1

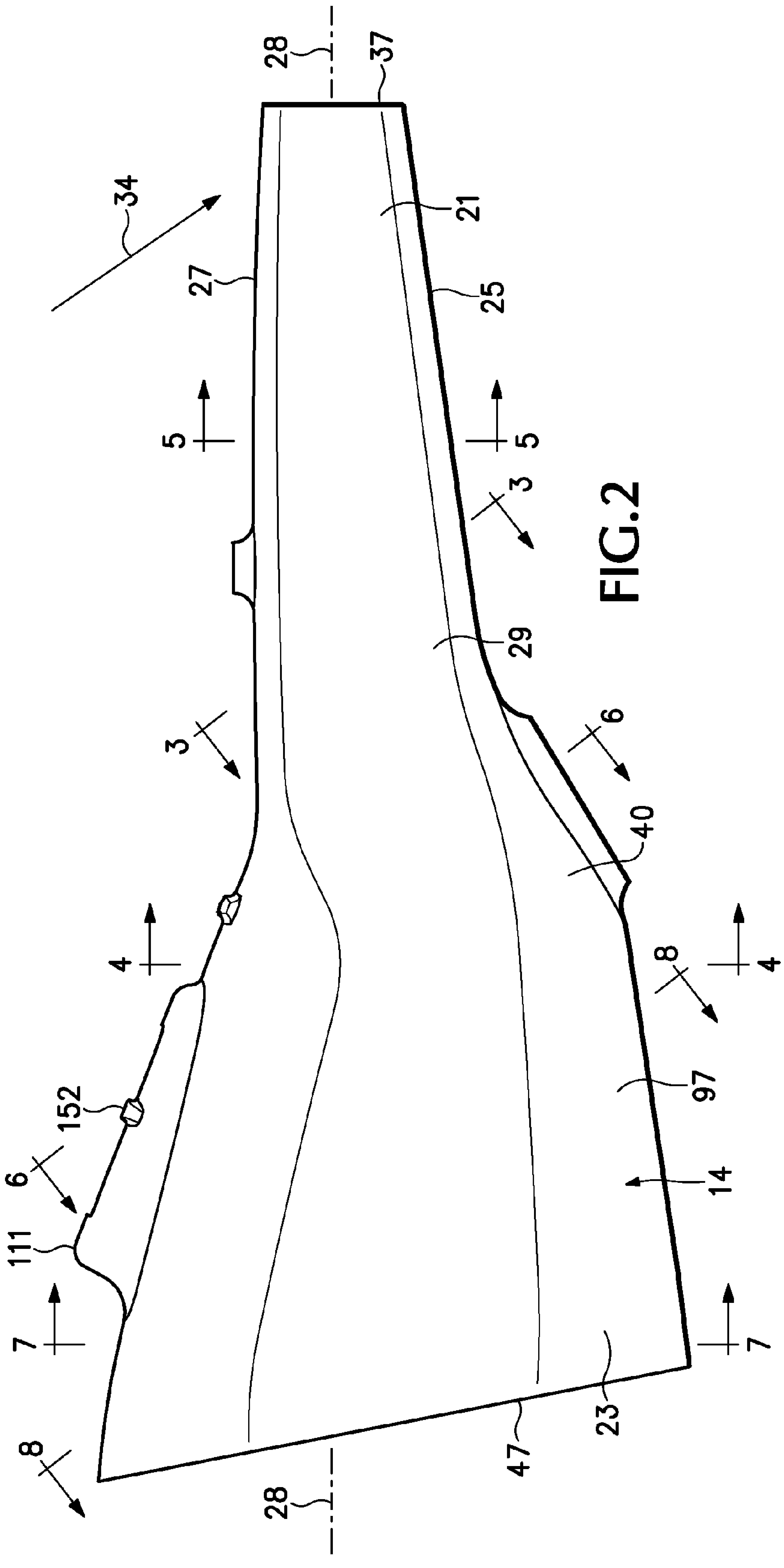

FIG.2

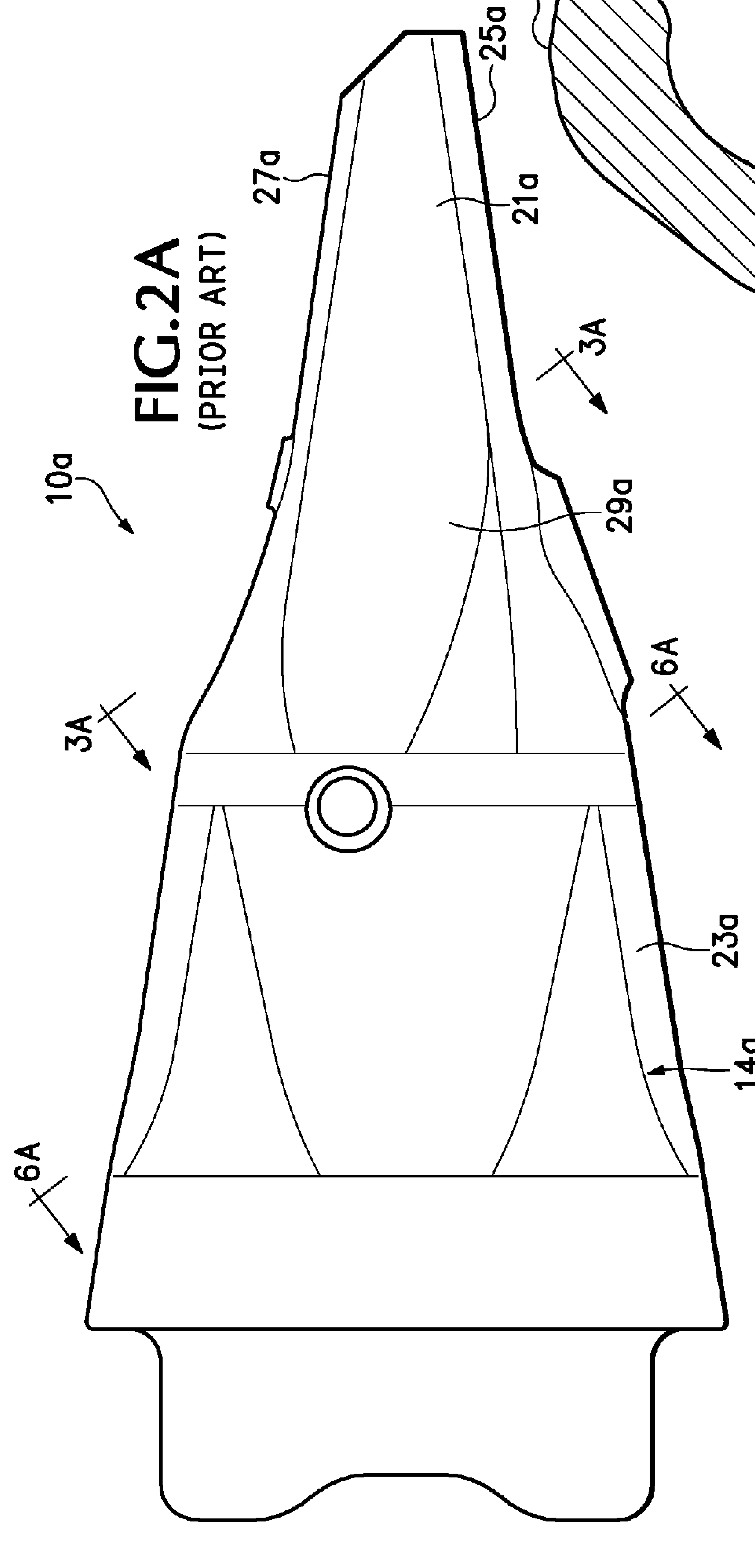

FIG.2A
(PRIOR ART)

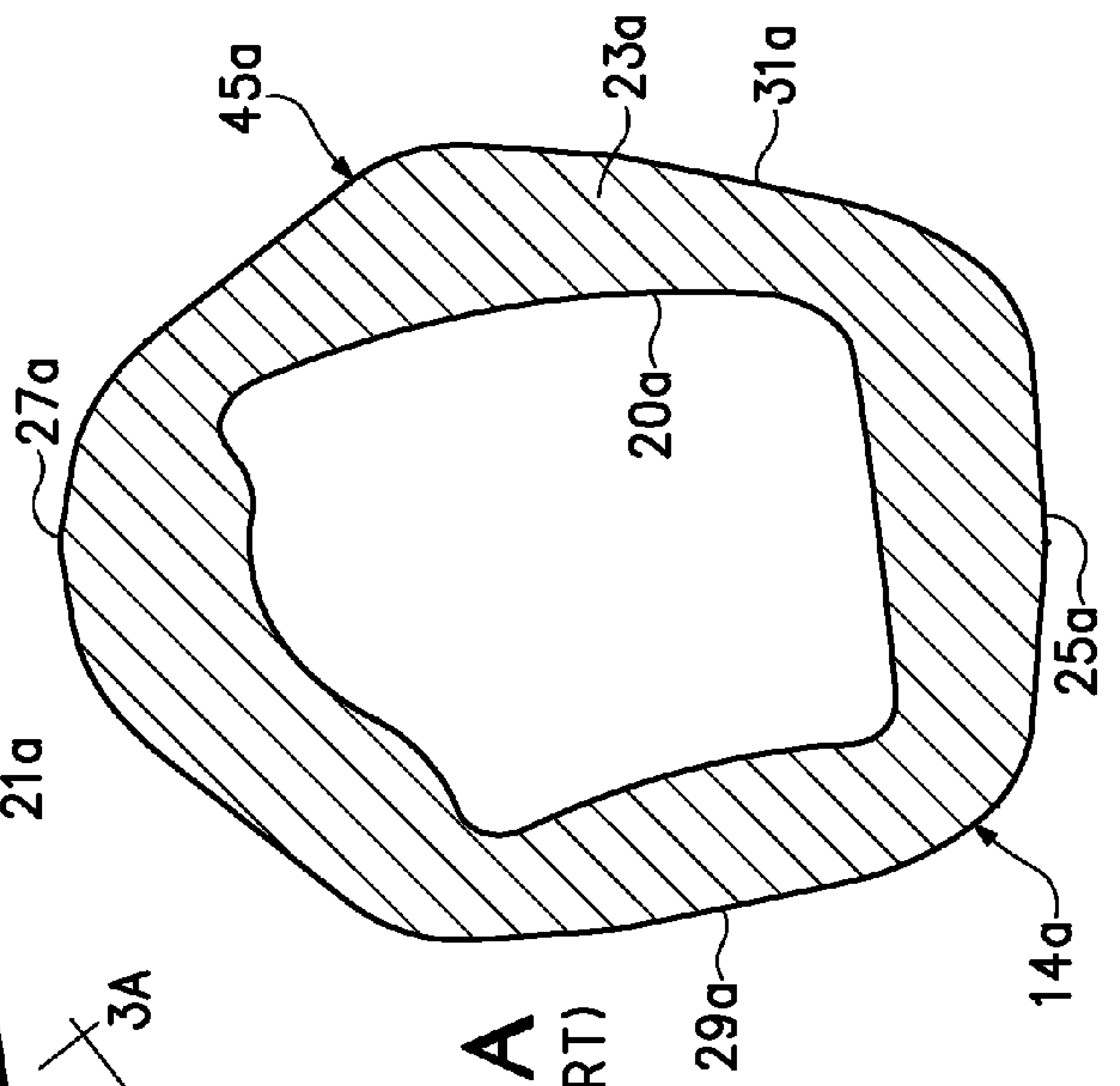

FIG.6A
(PRIOR ART)

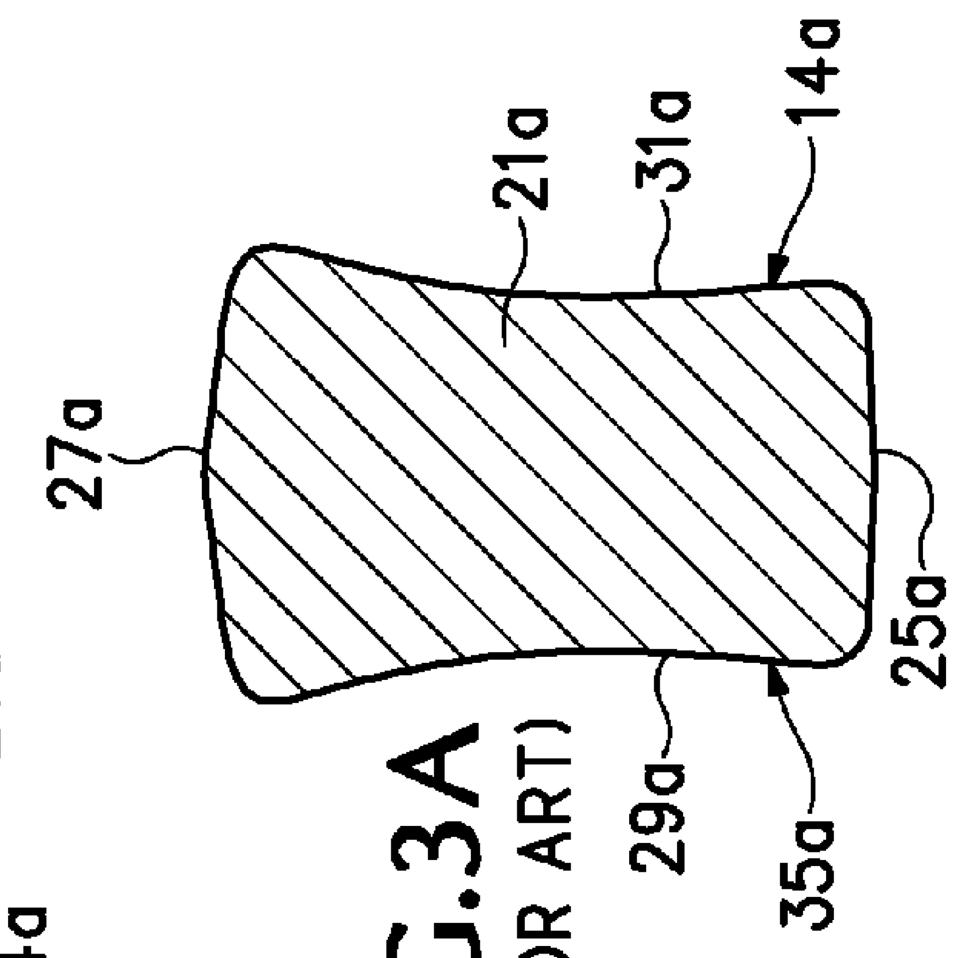

FIG.3A
(PRIOR ART)

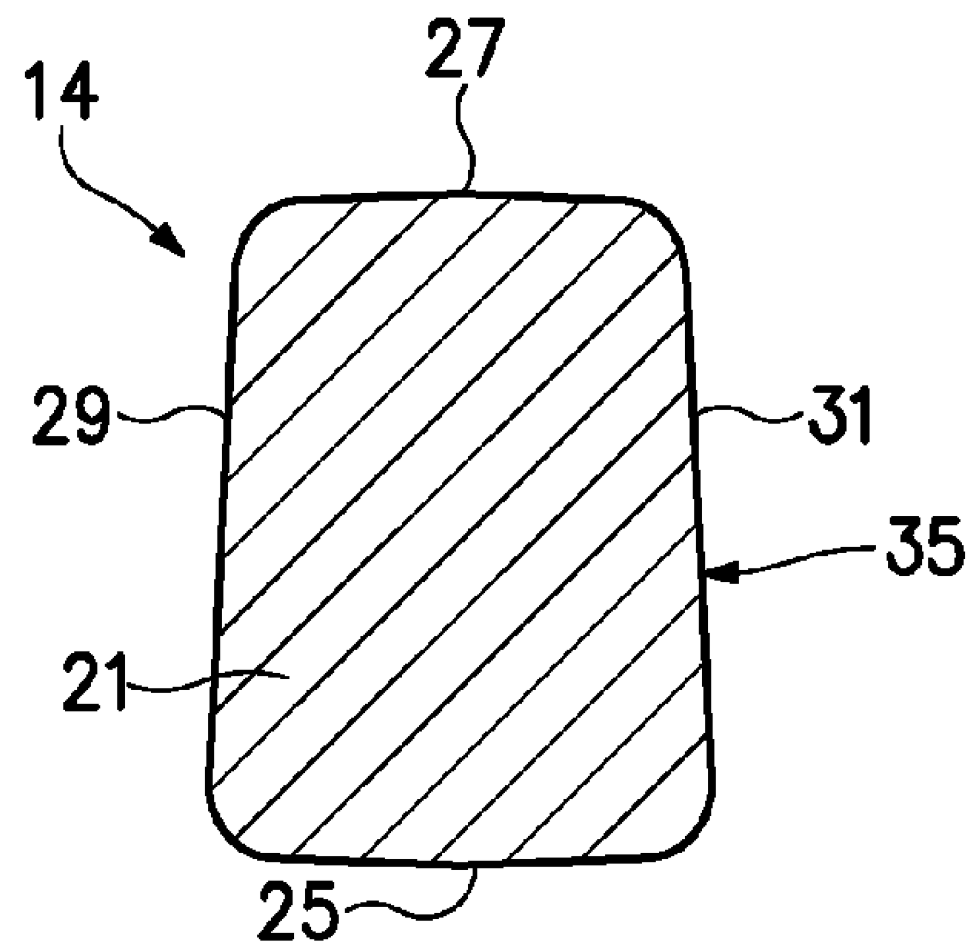

FIG.3

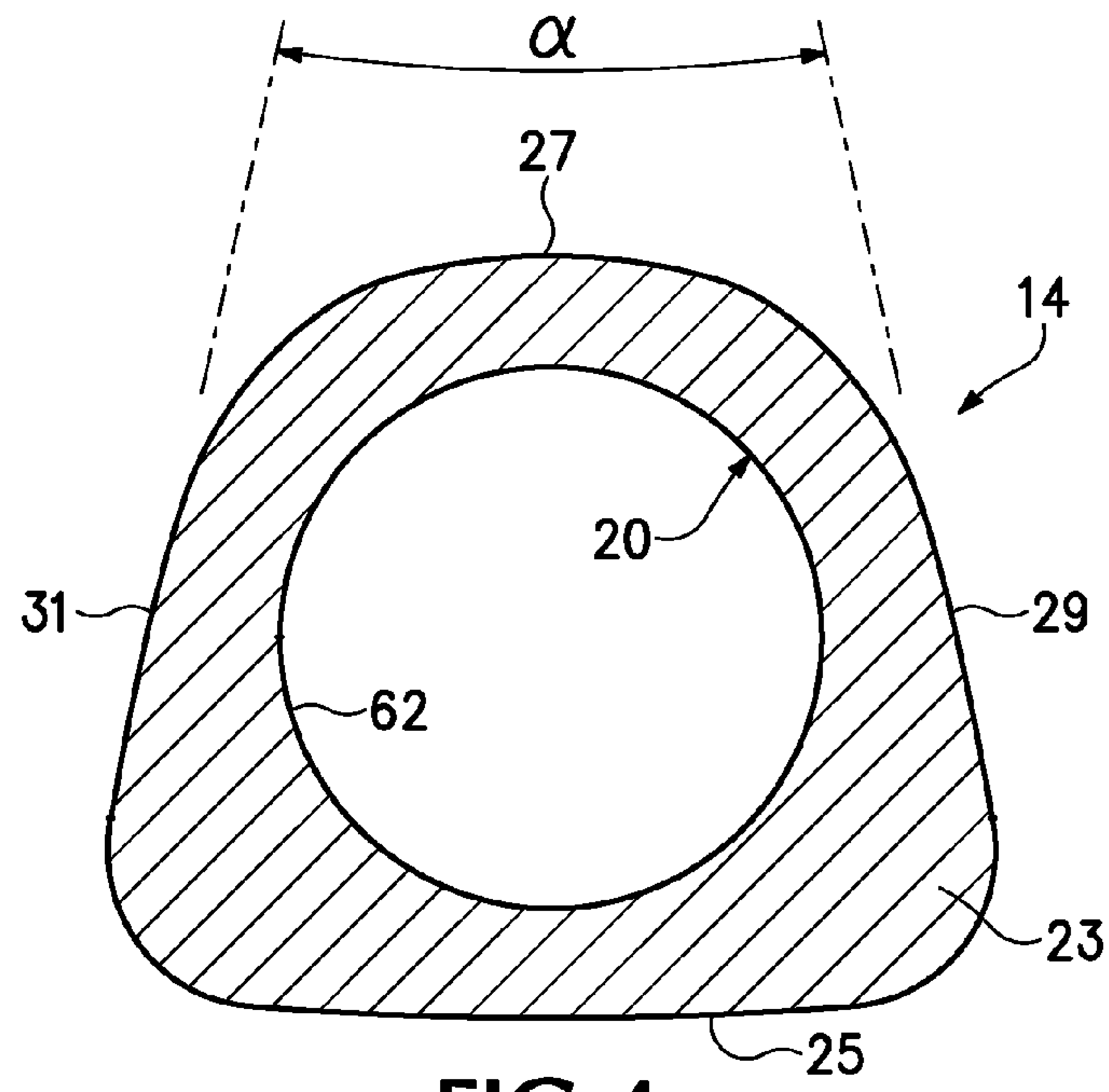

FIG.4

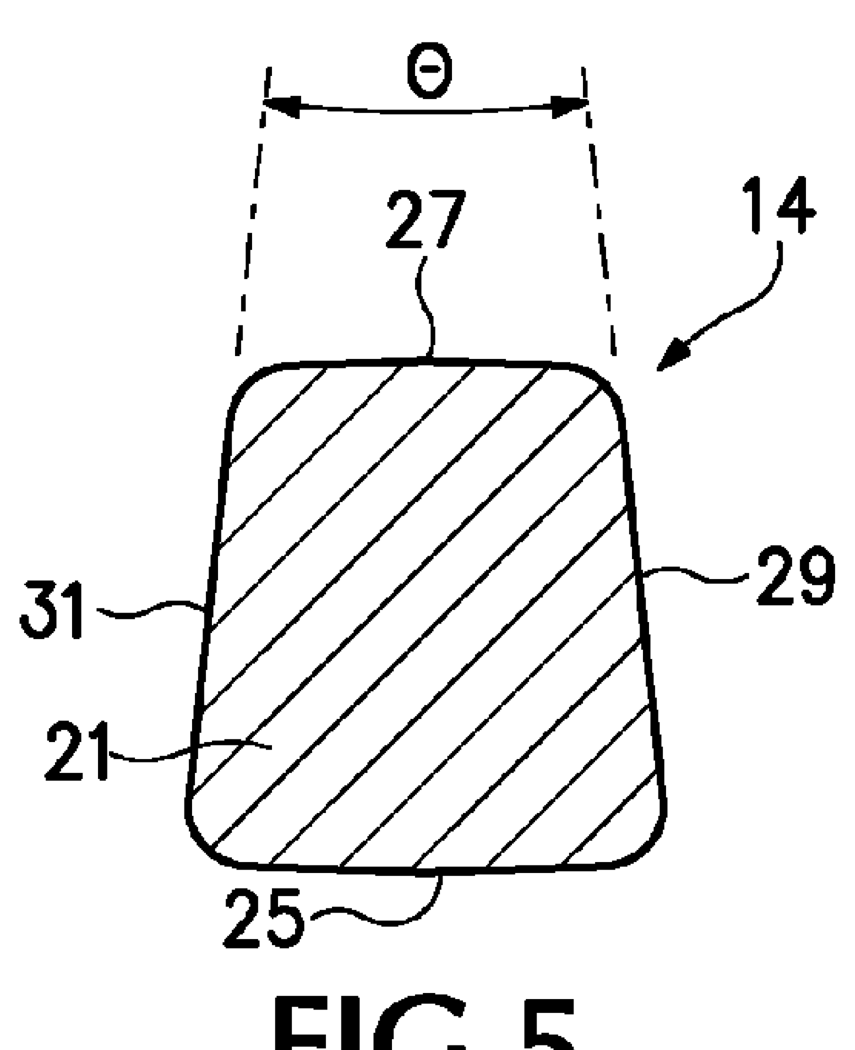

FIG.5

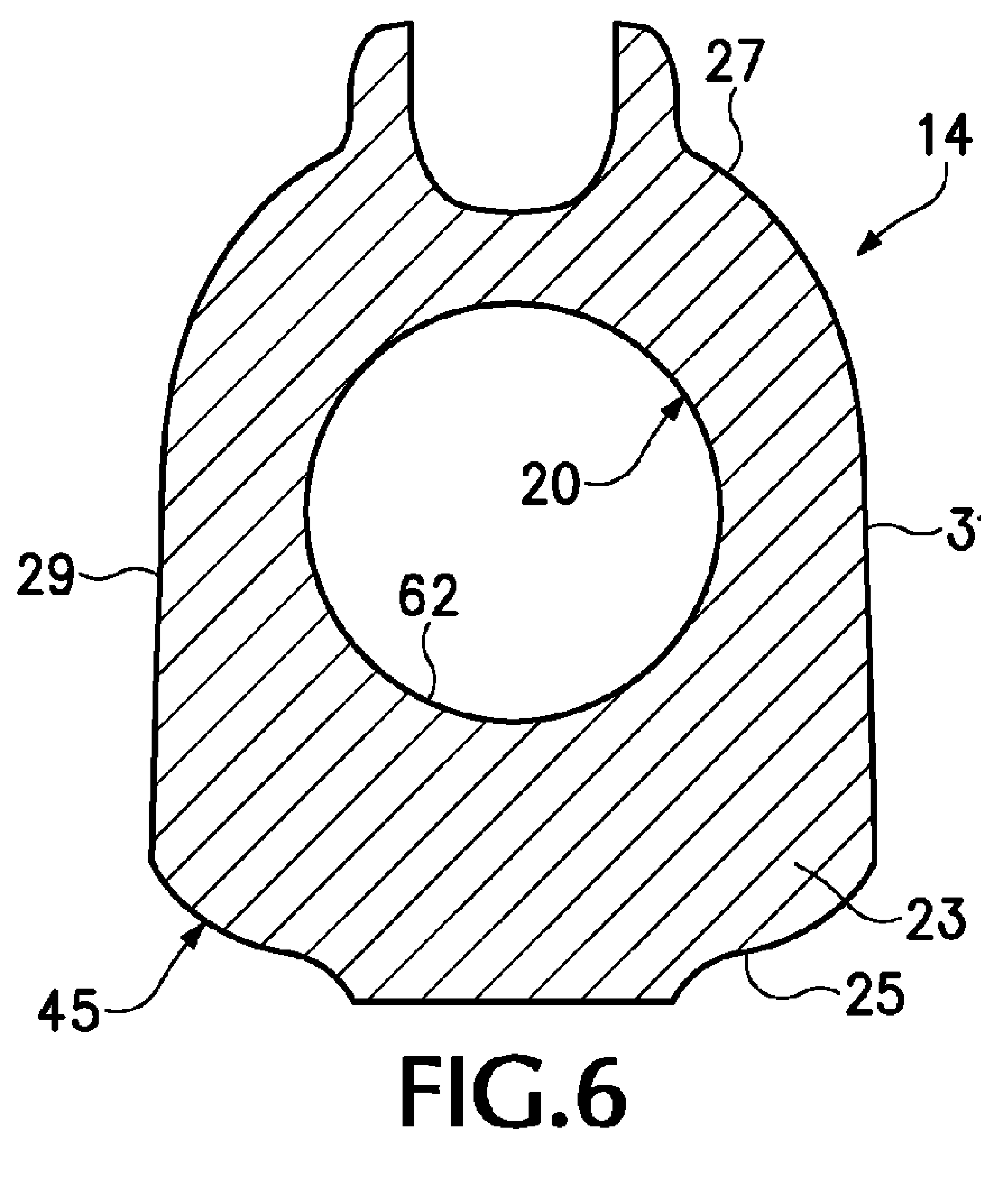

FIG.6

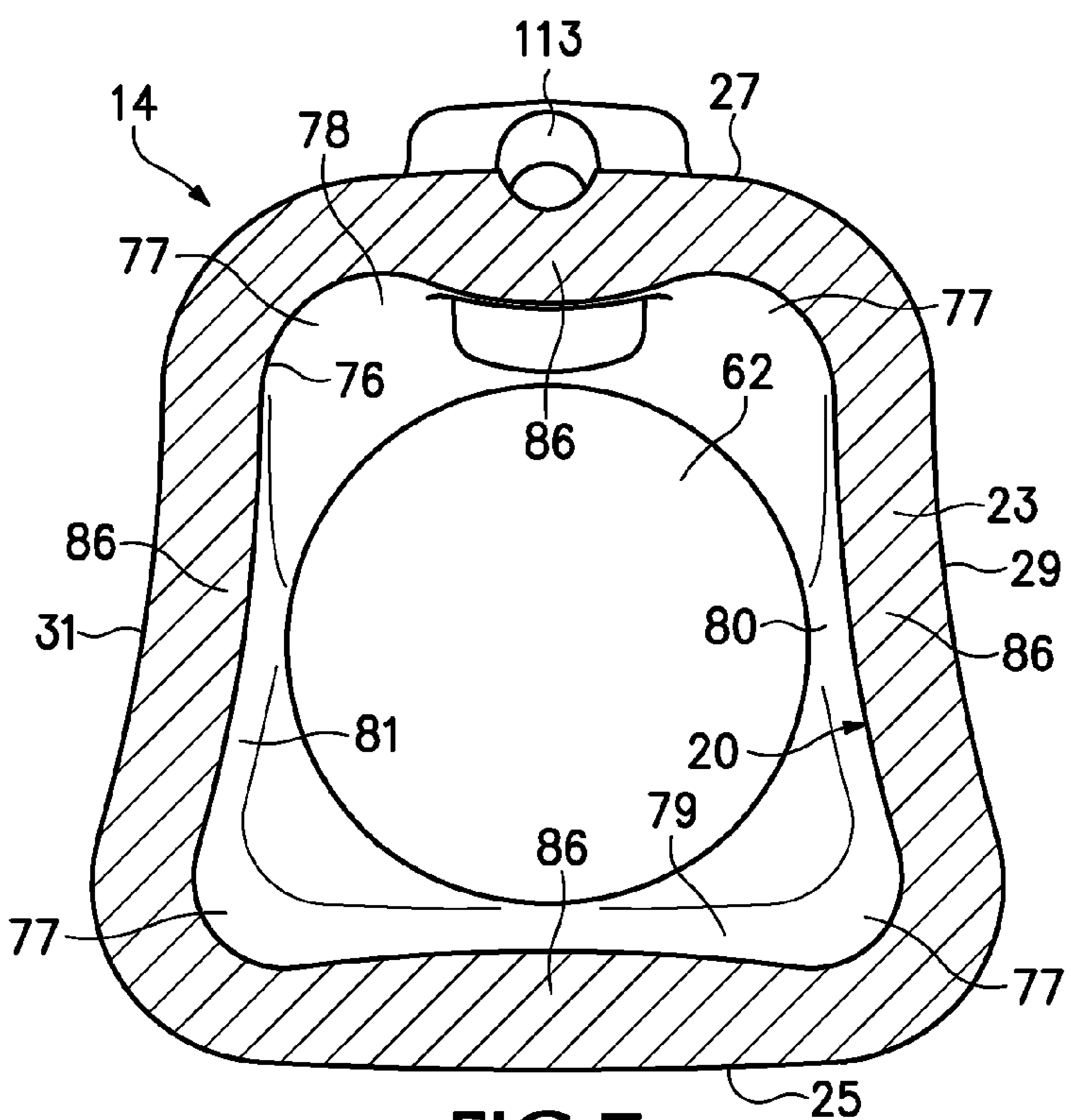
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FIG.7

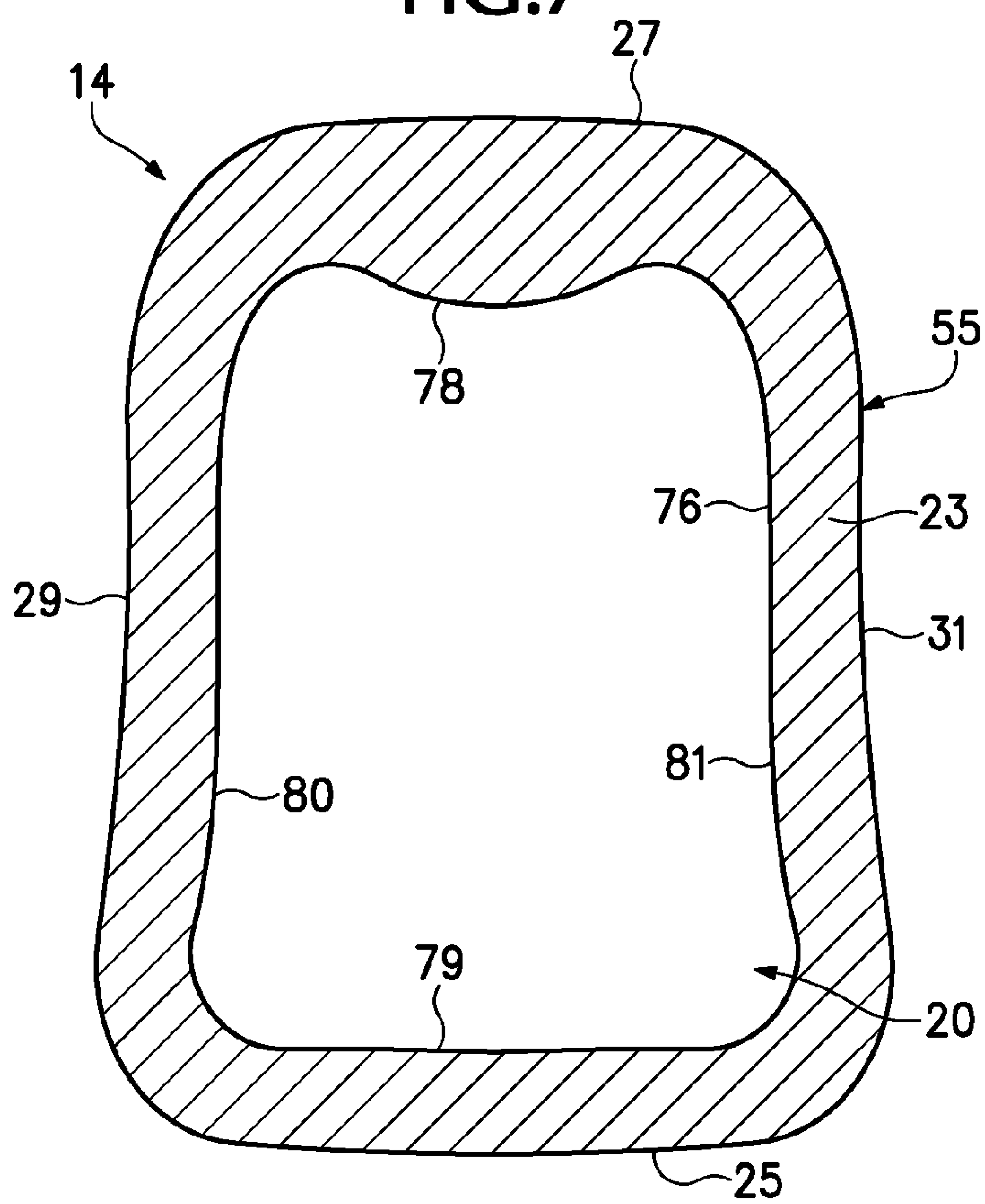
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FIG.8

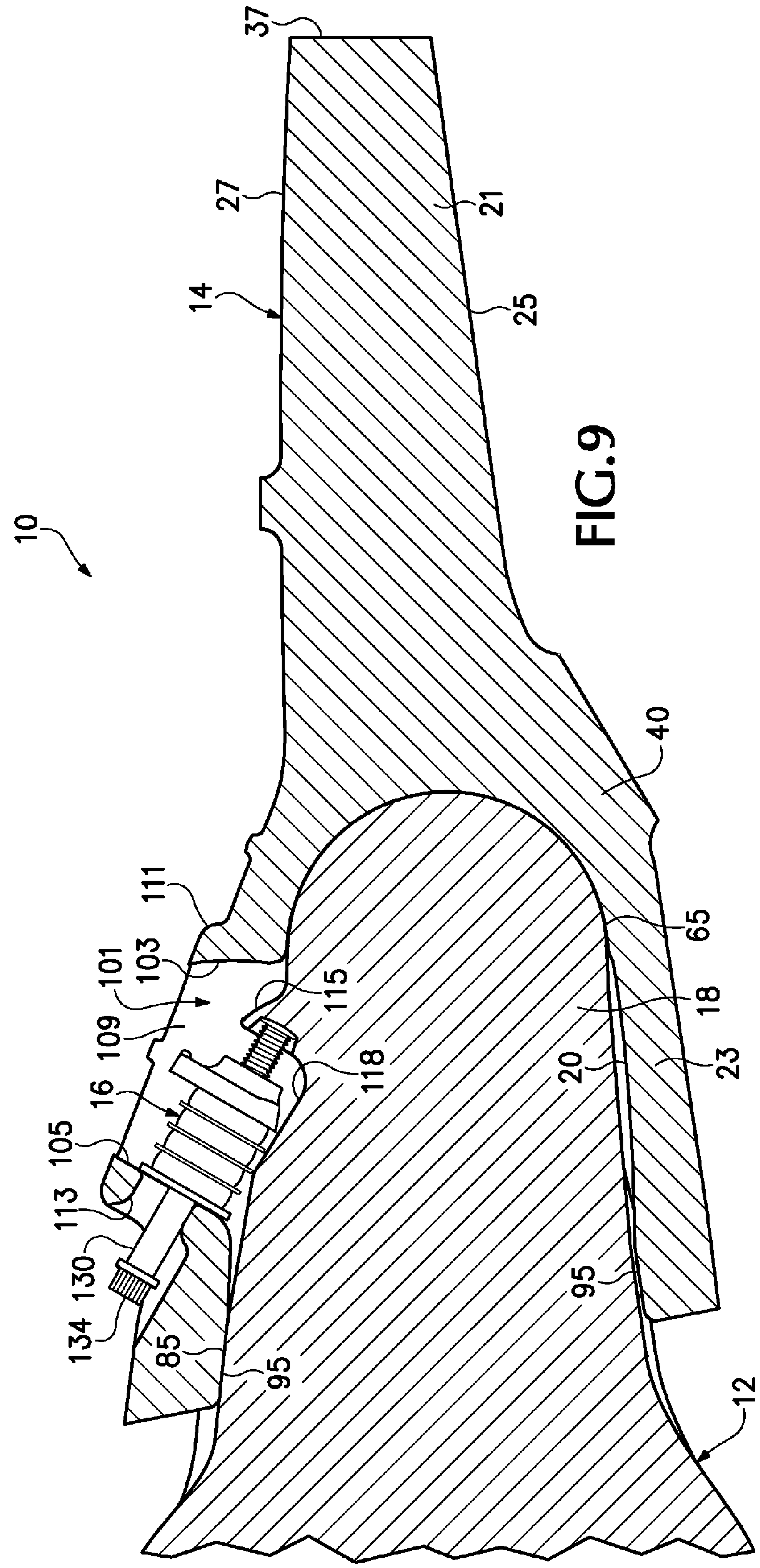
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FIG.9

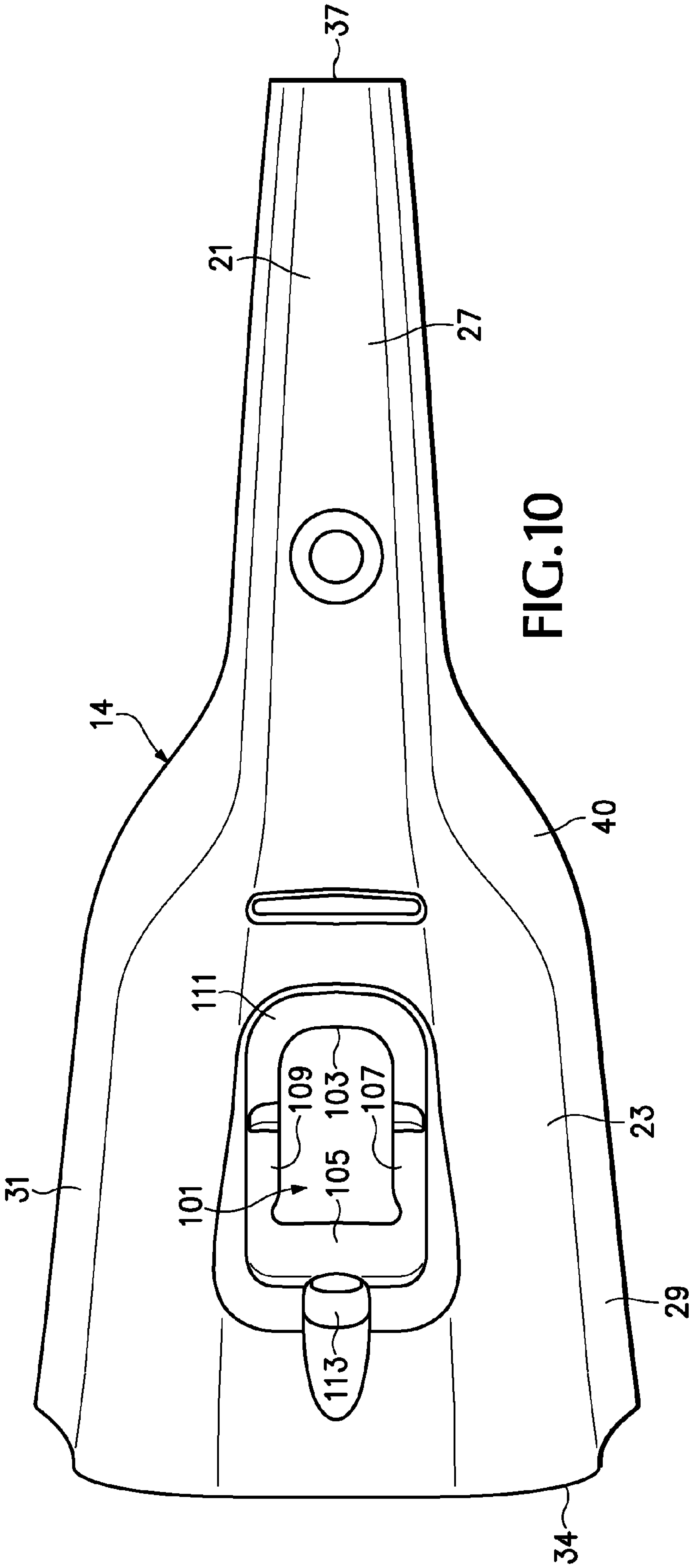

FIG.10

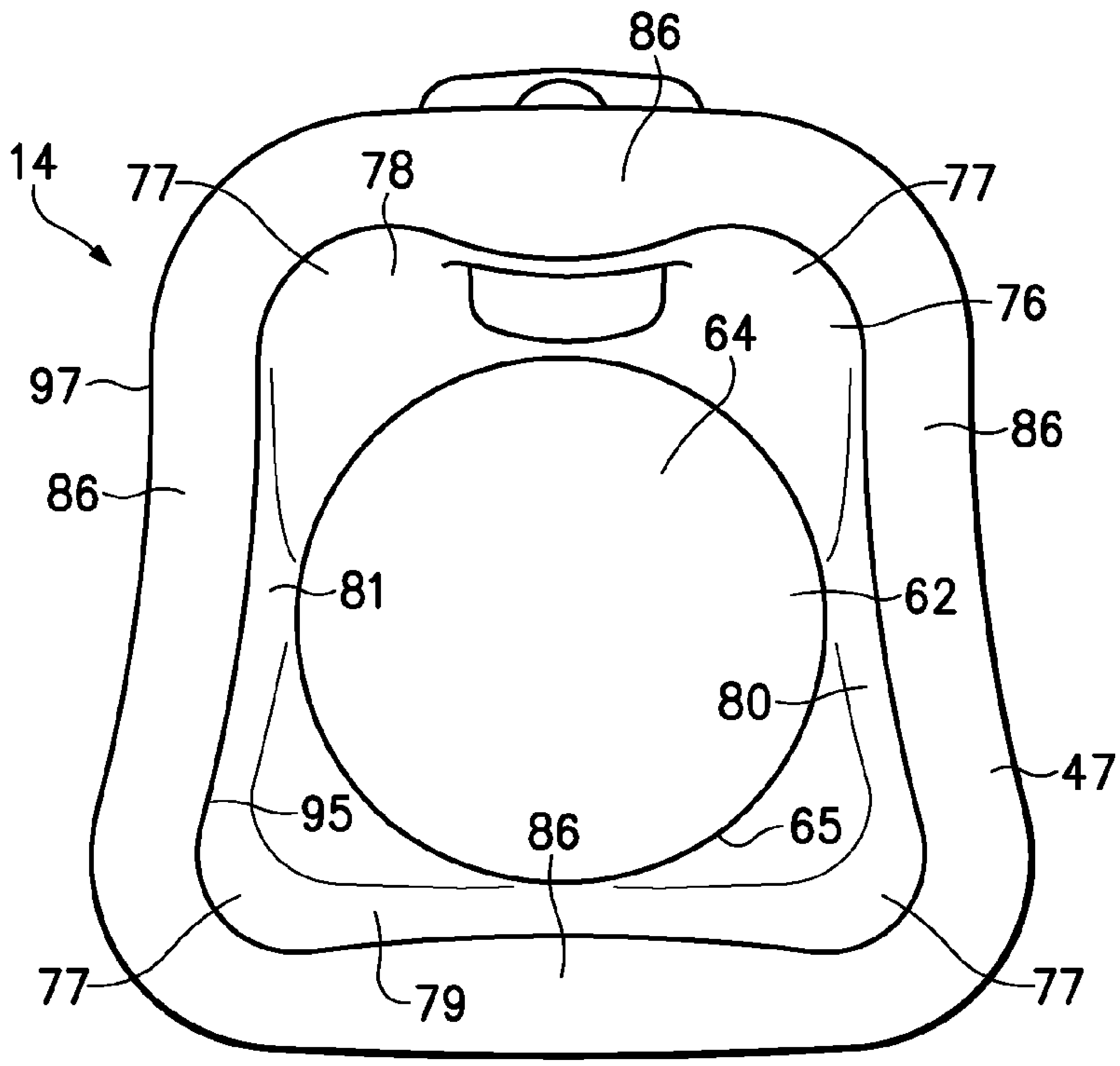
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FIG.11

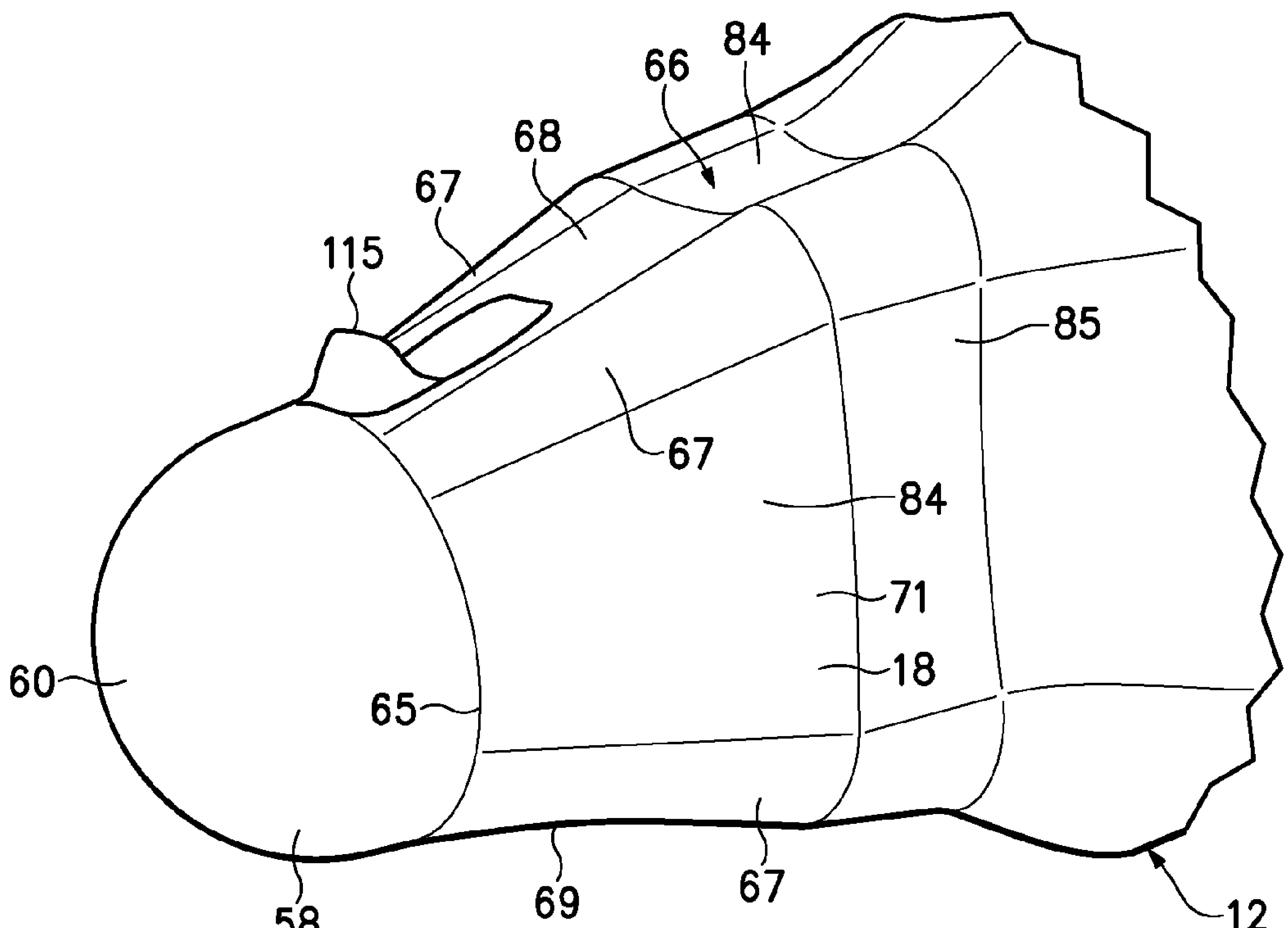
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FIG.12

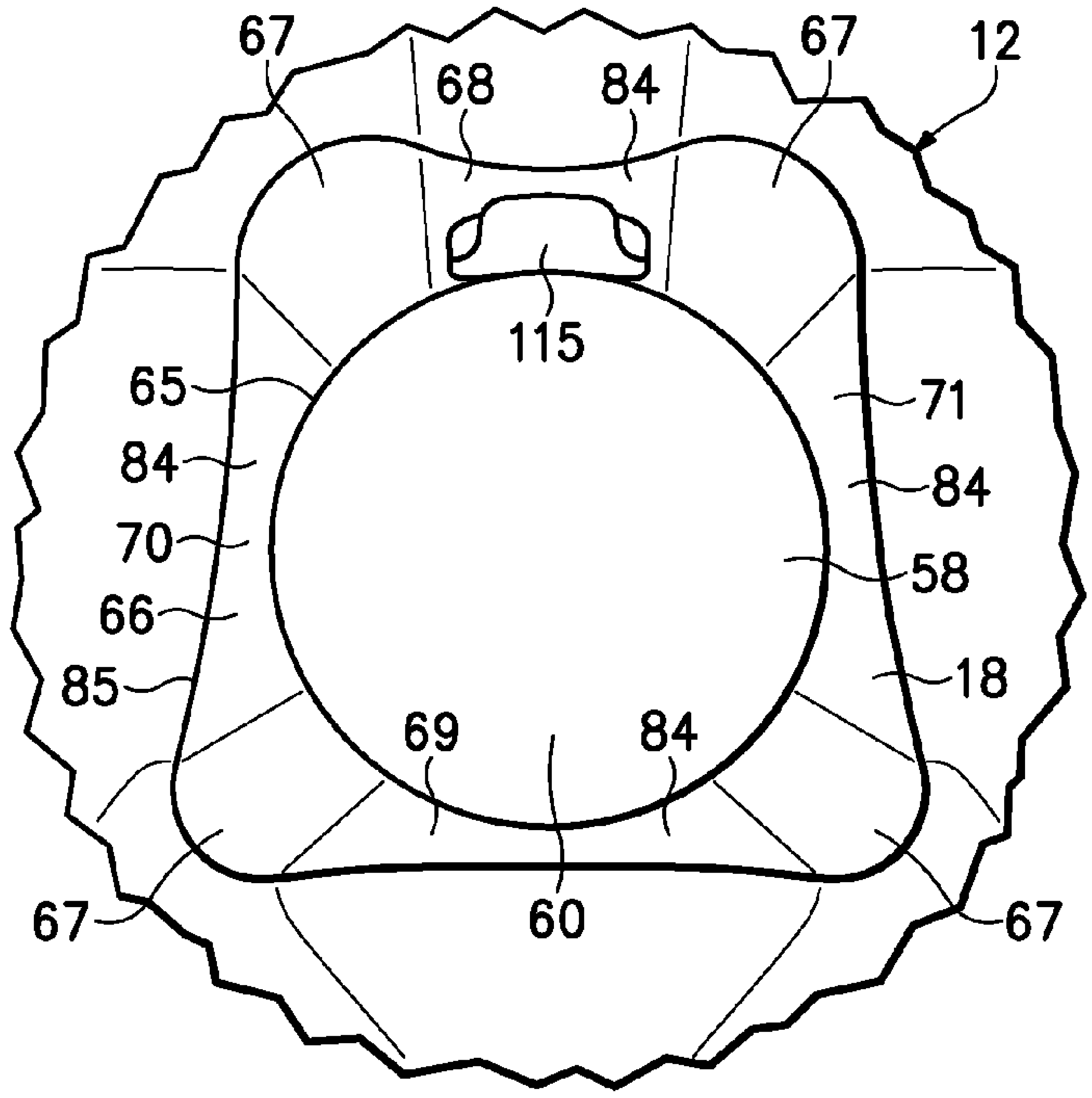
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FIG.13

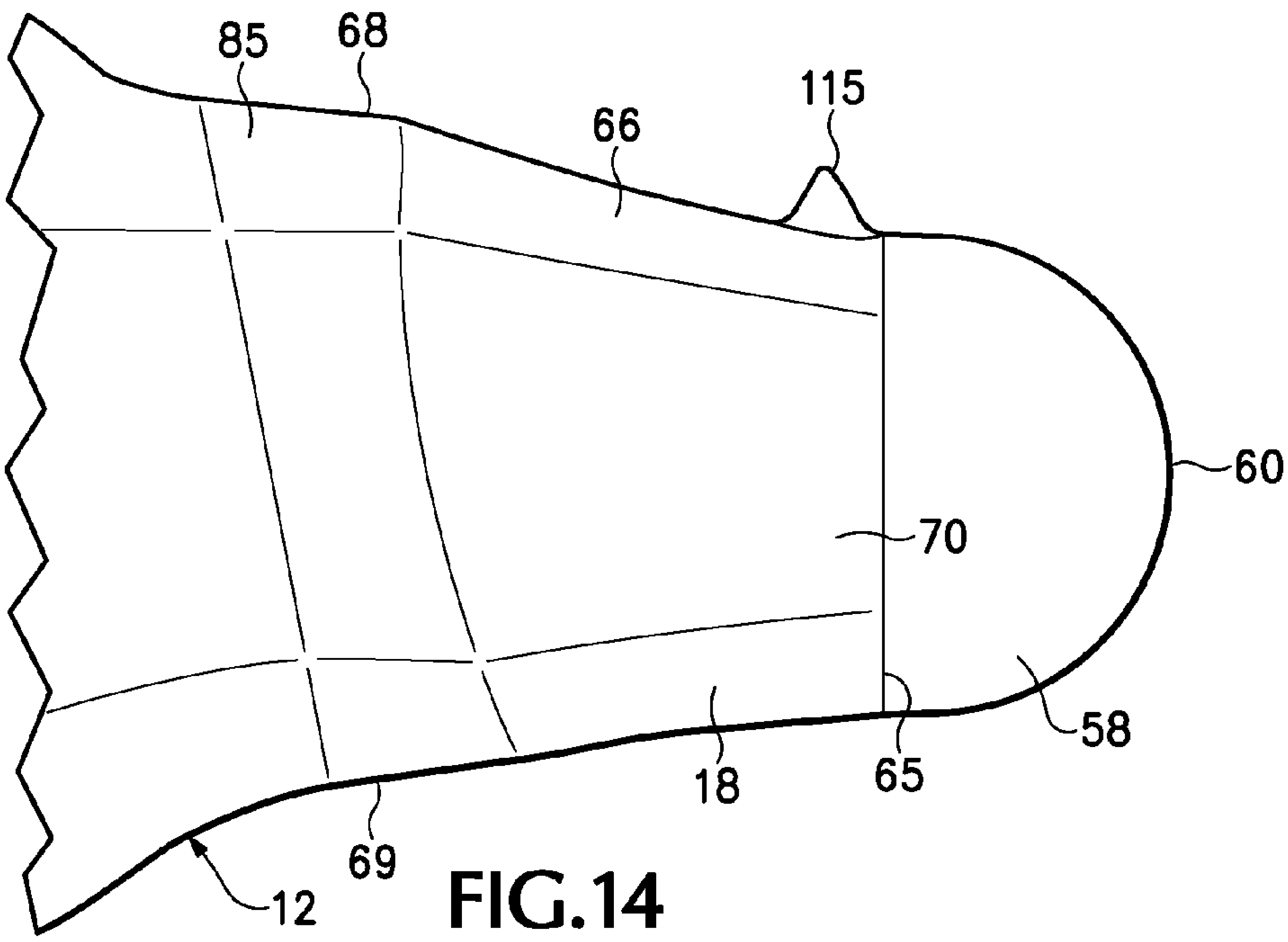
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FIG.14

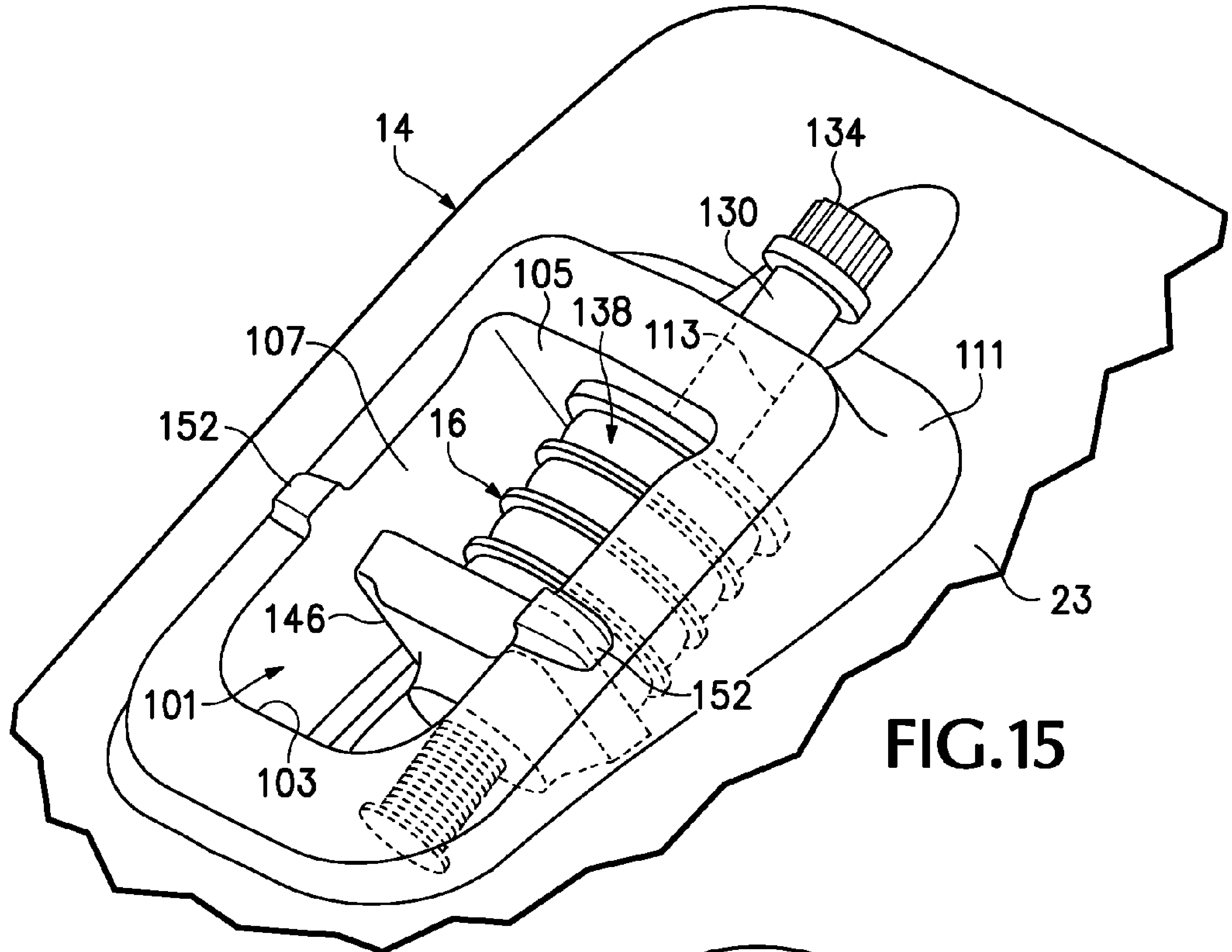
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FIG.15

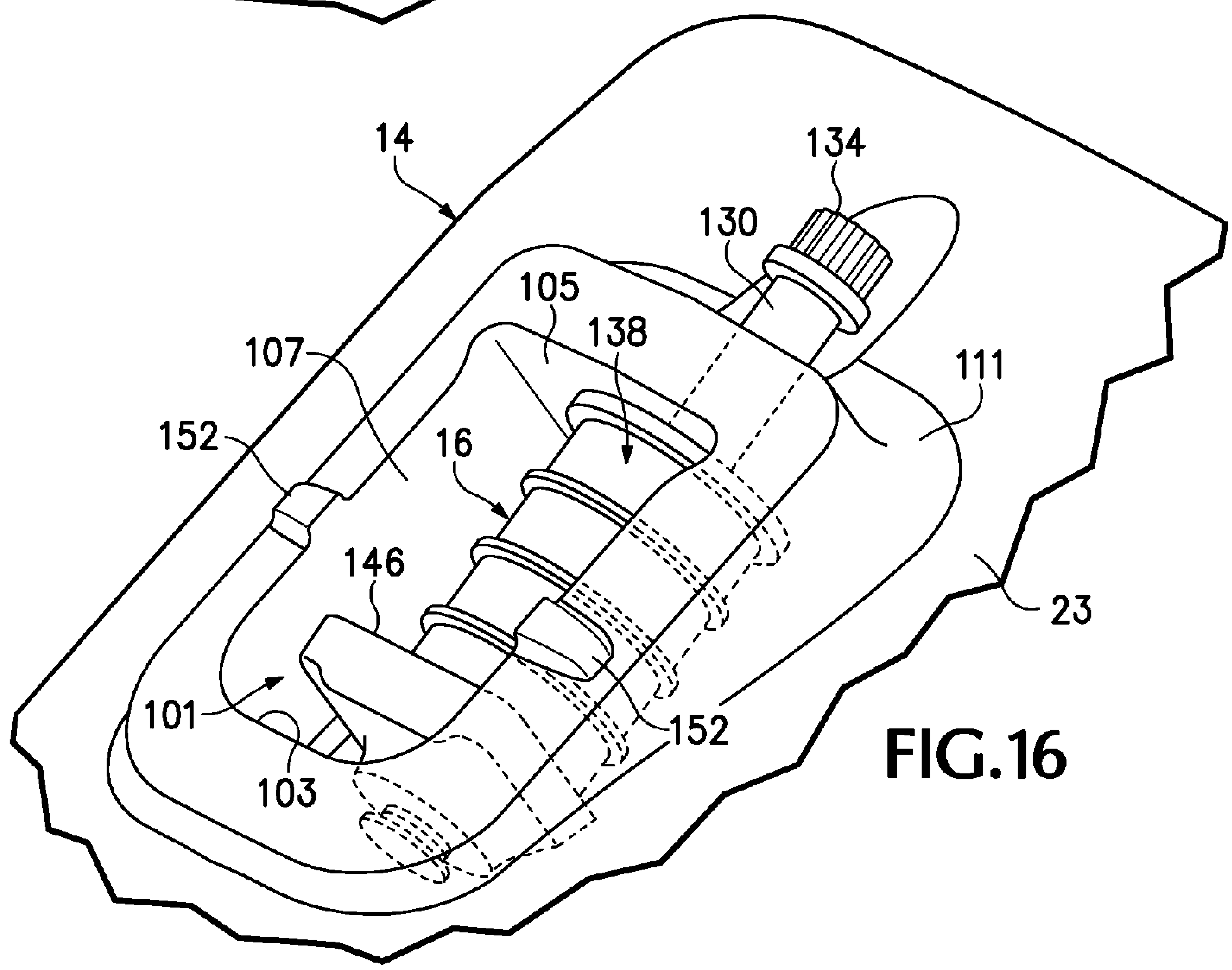
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FIG.16

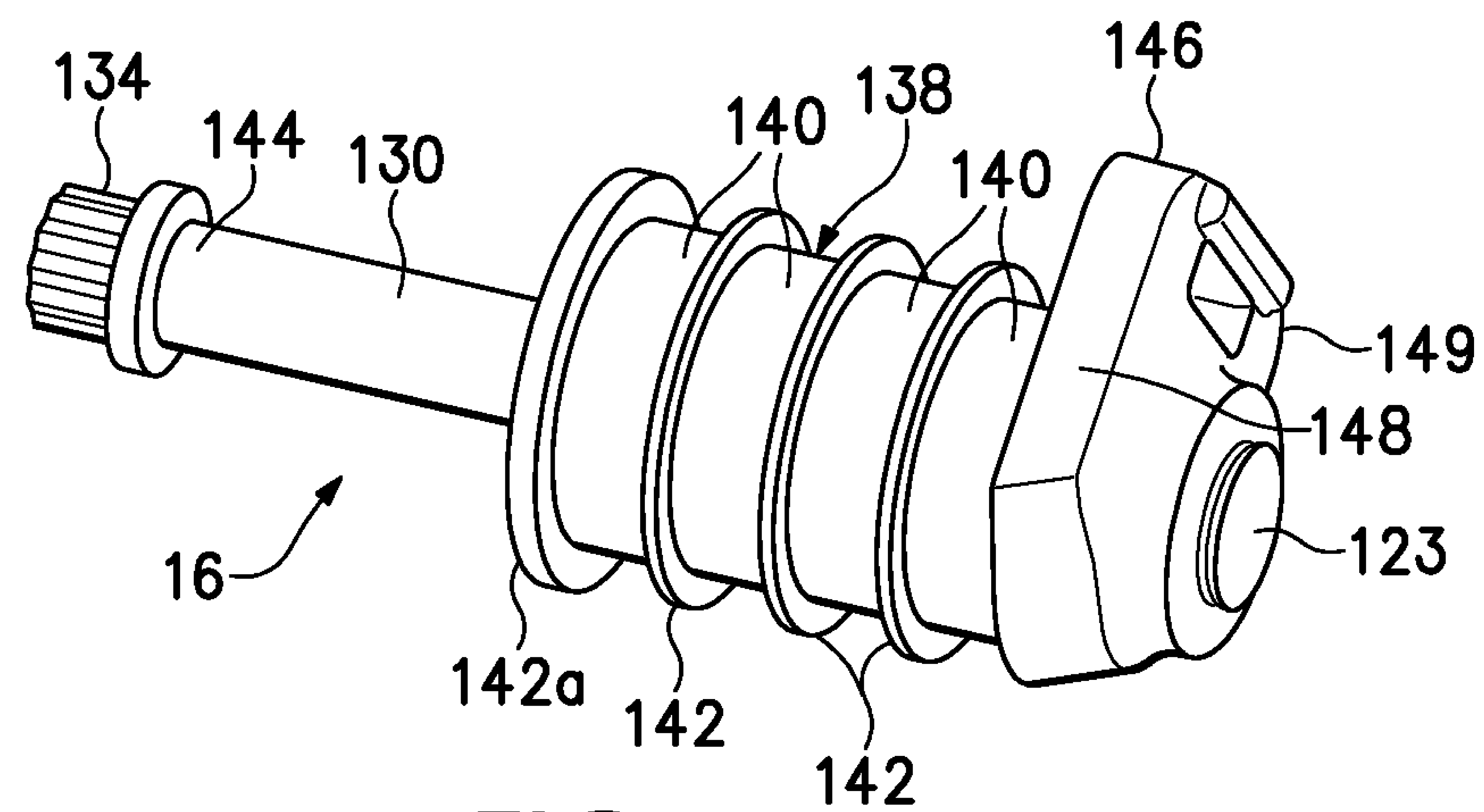
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FIG.17

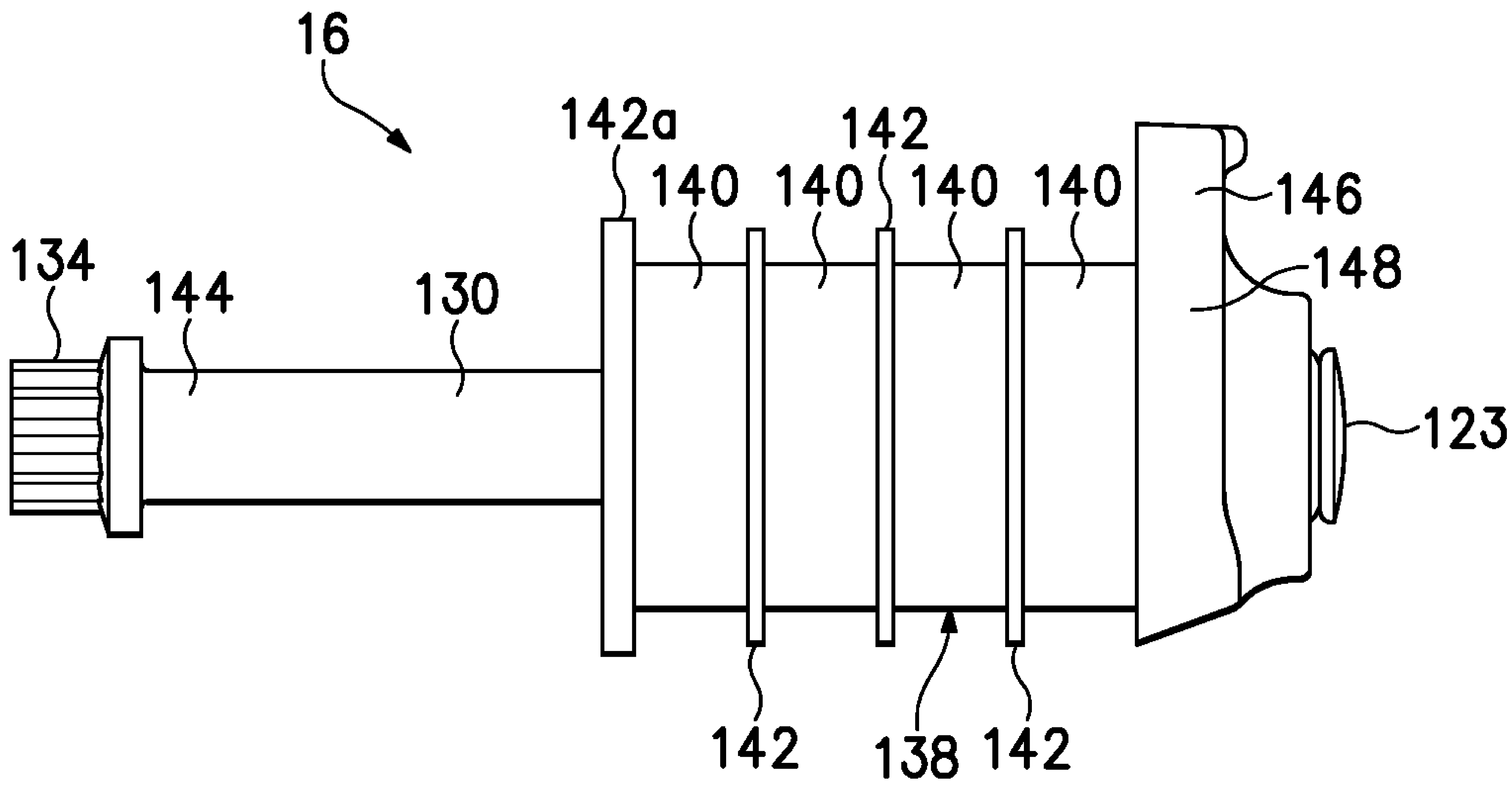
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FIG.18

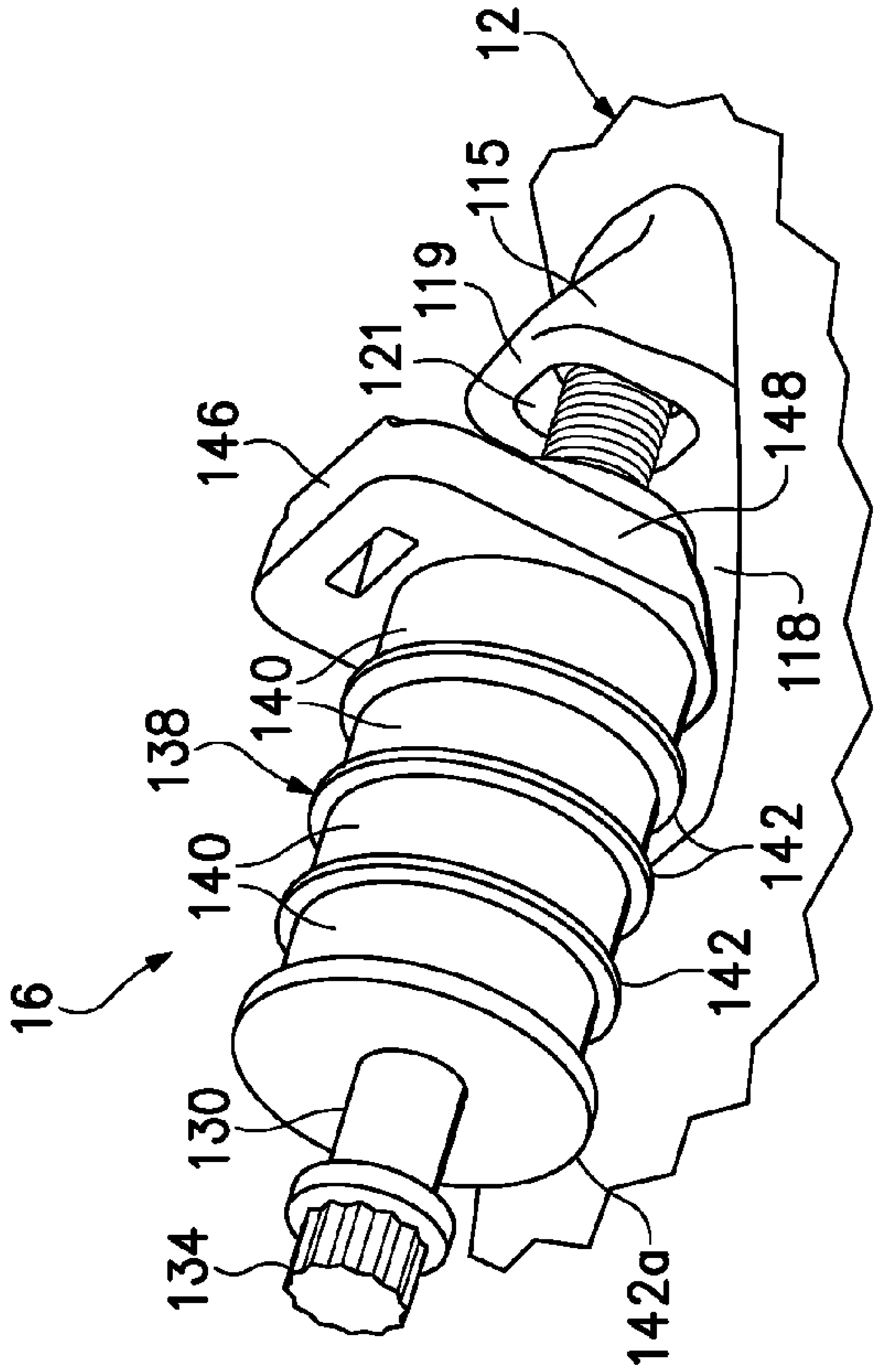
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FIG.20

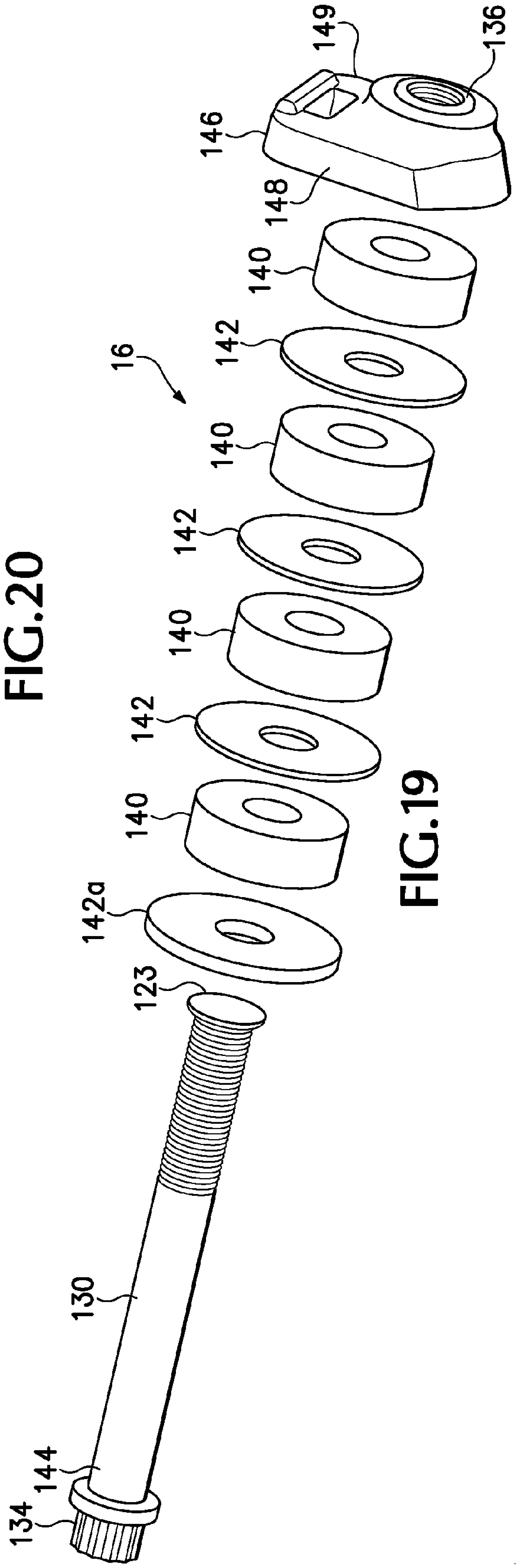
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FIG.19

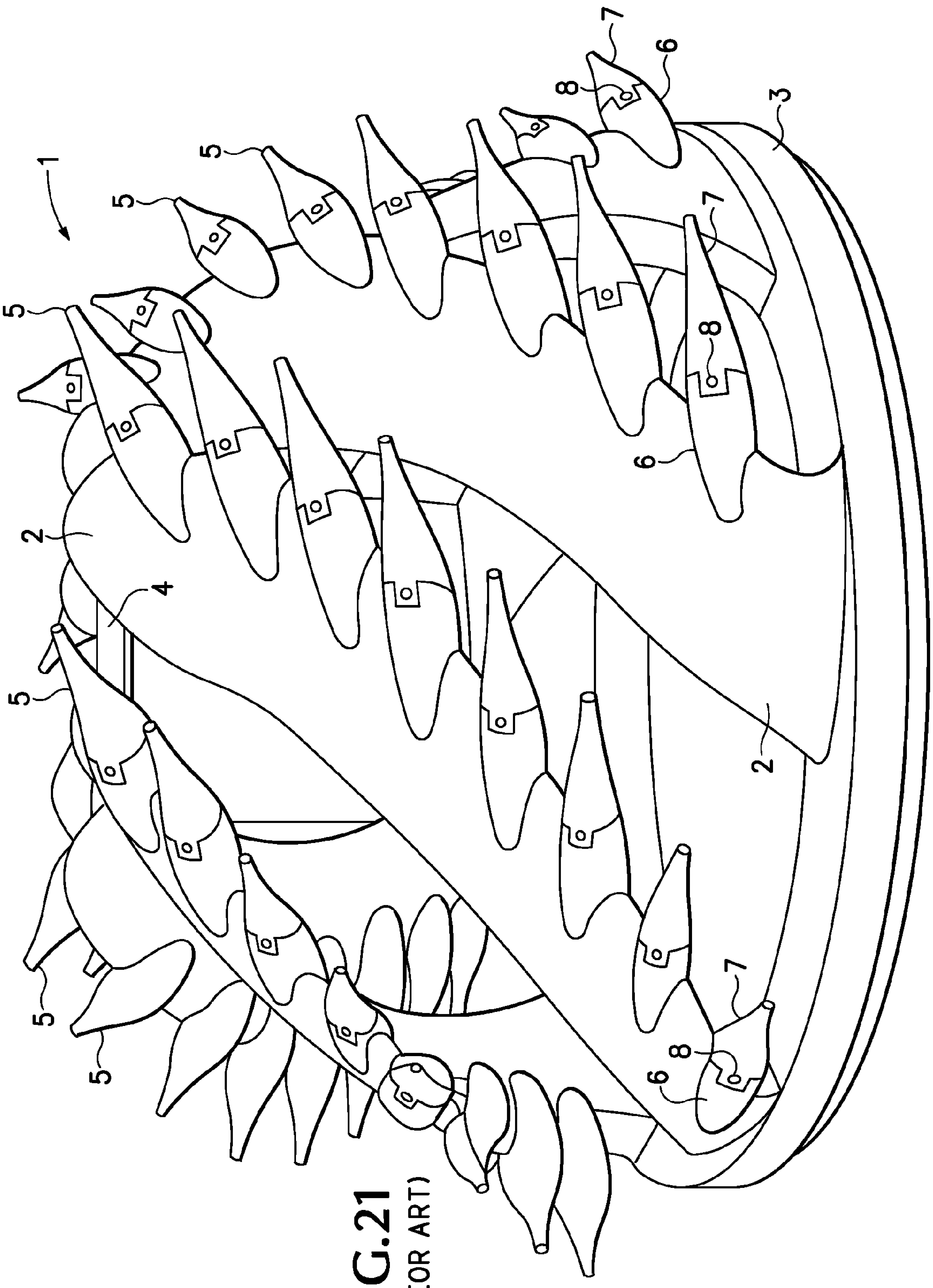

FIG.21
(PRIOR ART)

WEAR ASSEMBLY FOR EXCAVATING EQUIPMENT

This application is a divisional of application Ser. No. 12/613,467 filed Nov. 5, 2009, now U.S. Pat. No. 8,061,064 issued Nov. 22, 2011, which is a continuation of international application number PCT/US2008/062724 filed May 6, 2008, which claims the benefit of provisional patent application Ser. No. 60/928,780, filed May 10, 2007, provisional patent application Ser. No. 60/928,821 filed May 10, 2007, and provisional patent application Ser. No. 60/930,483 filed May 15, 2007.

FIELD OF THE INVENTION

The present invention pertains to a wear assembly for securing a wear member to excavating equipment, and in particular to a wear assembly that is well suited for attachment and use on a dredge cutterhead.

BACKGROUND OF THE INVENTION

Dredge cutterheads are used for excavating earthen material that is underwater, such as a riverbed. In general, a dredge cutterhead **1** includes several arms **2** that extend forward from a base ring **3** to a hub **4** (FIG. **21**). The arms are spaced about the base ring and formed with a broad spiral about the central axis of the cutterhead. Each arm **2** is provided with a series of spaced apart teeth **5** to dig into the ground. The teeth are composed of adapters or bases **6** that are fixed to the arms, and points **7** that are releasably attached to the bases by locks **8**.

In use, the cutterhead is rotated about its central axis to excavate the earthen material. A suction pipe is provided near the ring to remove the dredged material. To excavate the desired swath of ground, the cutterhead is moved side-to-side as well as forward. On account of swells and other movement of the water, the cutterhead also tends to move up and down, and periodically impact the bottom surface. Further difficulties are caused by the operator's inability to see the ground that is being excavated underneath the water; i.e., unlike most other excavating operations, the dredge cutterhead cannot be effectively guided along a path to best suit the terrain to be excavated. In view of the heavy loads and severe environment, the point and base interconnection needs to be stable and secure.

The cutterheads are rotated such that the teeth are driven into and through the ground at a rapid rate. Consequently, considerable power is needed to drive the cutterhead, particularly when excavating in rock. In an effort to minimize the power requirements, dredge points are typically provided with elongate, slender bits for easier penetration of the ground. However, as the bit becomes shorter due to wear, the mounting sections of the points will begin to engage the ground in the cutting operation. The mounting section is wider than the bit and is not shaped for reduced drag. On account of the resulting increased drag the mounting sections impose on the cutterhead, the points are usually changed at this time before the bits are fully worn away.

SUMMARY OF THE INVENTION

In accordance with one aspect of the invention, a wear member for excavating equipment is formed with side relief in the working and mounting sections to minimize the drag associated with the digging operation and, in turn, minimize the power needed to drive the equipment. Reduced power consumption, in turn, leads to a more efficient operation and a longer usable life for the wear member.

In accordance with the invention, the wear member has a transverse configuration where the width of the leading side is larger than the width of the corresponding trailing side so that the sidewalls of the wear member follow in the shadow of the leading side to decrease drag. This use of a smaller trailing side is provided not only through the working end but also at least partially into the mounting end. As a result, the drag experienced by a worn wear member of the invention is less than that of a conventional wear member. Less drag translates into less power consumption and a longer use of the wear member before it needs to be replaced. Accordingly, the working ends of the wear member can be further worn away before replacement is needed.

In accordance with another aspect of the invention, the wear member has a digging profile that is defined by the transverse configuration of that portion of the wear member that penetrates the ground in one digging pass and in the direction of motion through the ground. In one other aspect of the present invention, side relief in the wear member is provided in the digging profile to lessen the drag experienced during a digging operation. In a preferred embodiment, side relief is provided in every digging profile expected through the life of the wear member including those which encompass the mounting section.

In another aspect of the invention, the wear member includes a socket for receiving a nose of a base fixed to the excavating equipment. The socket is formed with a generally trapezoidal transverse shape that generally corresponds to the transverse trapezoidal exterior profile of the wear member. This general matching of the socket to the exterior of the mounting section eases manufacture, maximizes the size of the nose, and enhances the strength to weight ratio.

In a preferred construction, one or more of the top, bottom or side surfaces of a trapezoidal shaped nose and the corresponding walls of the socket are each bowed to fit together. These surfaces and walls have a gradual curvature to ease installation, enhance stability of the wear member, and resist rotation of the wear member about the longitudinal axis during use.

In accordance with another aspect of the invention, the socket and nose each includes rear stabilizing surfaces that extend substantially parallel to the longitudinal axis of the wear member and substantially around the perimeter of the socket and nose to resist rearward loads applied in all directions.

In accordance with another aspect of the invention, the socket and nose are formed with complementary front bearing faces that are substantially hemispherical to lessen stress in the components and to better control the rattle that occurs between the wear member and the base.

In another aspect of the invention, the socket and nose are formed with front curved bearing faces at their front ends, and with generally trapezoidal transverse shapes rearward of the front ends to improve stability, ease manufacture, maximize the size of the nose, reduce drag, stress and wear, and enhance the strength to weight ratio.

In accordance with another aspect of the invention, the wear assembly includes a base, a wear member that mounts to the base, and an axially oriented lock that in a compressive state holds the wear member to the base in a manner that is secure, easy to use, readily manufactured, and can tighten the fit of the wear member on the base. In one preferred embodiment, the wear assembly includes an adjustable axial lock.

In another aspect of the invention, the wear member includes an opening into which the lock is received, and a hole that is formed in a rear wall of the opening to accommodate passage of a lock to stabilize the lock and facilitate easy tightening of the lock.

In another aspect of the invention, the base interacts with the lock solely through the use of a projecting stop. As a result, there is no need for a hole, recess or passage in the nose such as is typically provided to receive the lock. The nose strength is thus enhanced.

In another aspect of the invention, the locking arrangement for securing the wear member to the base can be adjusted to consistently apply a predetermined tightening force to the wear member irrespective of the amount of wear that may exist in the base and/or wear member.

In another aspect of the invention, the wear member includes a marker that can be used to identify when the lock has been adequately tightened.

In another aspect of the invention, the wear member is installed and secured to the base through an easy to use, novel process involving an axial lock. The wear member fits over a nose of a base fixed to the excavating equipment. The base includes a stop that projects outward from the nose. An axial lock is received into an opening in the wear member and extends between the stop and a bearing surface on the wear member to releasably hold the wear member to the nose.

In another aspect of the invention, the wear member is first slid over a base fixed to the excavating equipment. An axially oriented lock is positioned with one bearing face against a stop on the base and another bearing face against a bearing wall on the wear member such that the lock is in axial compression. The lock is adjusted to move the wear member tightly onto the base.

In another aspect of the invention, a lock to releasably hold a wear member to a base includes a threaded linear shaft, with a bearing end and a tool engaging end, a nut threaded onto the shaft, and a spring including a plurality of alternating annular elastomeric disks and annular spacers fit about the threaded shaft between the bearing end and the nut.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a wear assembly in accordance with the present invention.

FIG. **2** is a side view of a wear member of the invention.

FIG. **2**A is a side view of a conventional wear member.

FIG. **3** is a cross-sectional view taken along line **3-3** in FIG. **2**.

FIG. **3**A is a cross-sectional view taken along line **3**A-**3**A in FIG. **2**A.

FIG. **4** is a cross-sectional view taken along line **4-4** in FIG. **2**.

FIG. **5** is a cross-sectional view taken along line **5-5** in FIG. **2**.

FIG. **6** is a cross-sectional view taken along line **6-6** in FIG. **2**.

FIG. **6**A is the cross-sectional view taken along line **6**A-**6**A in FIG. **2**A.

FIG. **7** is a cross-sectional view taken along line **7-7** in FIG. **2**.

FIG. **8** is a cross-sectional view taken along line **8-8** in FIG. **2**.

FIG. **9** is a cross-sectional view taken along line **9-9** in FIG. **1**.

FIG. **10** is a top view of the wear member.

FIG. **11** is a rear view of the wear member.

FIG. **12** is a perspective view of a nose of a base of the invention.

FIG. **13** is a front view of the nose.

FIG. **14** is a side view of the nose.

FIG. **15** is an enlarged perspective view of a lock in the wear assembly.

FIG. **16** is an enlarged perspective view of the lock in the wear assembly prior to tightening.

FIG. **17** is a perspective view of the lock.

FIG. **18** is a side view of the lock.

FIG. **19** is an exploded, perspective view of the lock.

FIG. **20** is a perspective view of the lock with the nose (the point has been omitted).

FIG. **21** is a side view of a conventional dredge cutterhead.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention pertains to a wear assembly **10** for excavating equipment, and is particularly well suited for dredging operations. In this application, the invention is described in terms of a dredge tooth adapted for attachment to a dredge cutterhead. Nevertheless, the different aspects of the invention can be used in conjunction with other kinds of wear assemblies (e.g., shrouds) and for other kinds of excavating equipment (e.g., buckets).

The assembly is at times described in relative terms such as up, down, horizontal, vertical, front and rear; such terms are not considered essential and are provided simply to ease the description. The orientation of a wear member in an excavating operation, and particularly in a dredge operation, can change considerably. These relative terms should be understood with reference to the orientation of wear assembly **10** as illustrated in FIG. **1** unless otherwise stated.

Wear assembly **10** includes a base **12** secured to a dredge cutterhead, a wear member **14**, and a lock **16** to releasably hold the wear member to base **12** (FIGS. **1-10**).

Base **12** includes a forwardly projecting nose **18** onto which wear member **14** is mounted, and a mounting end (not shown) that is fixed to an arm of a dredge cutterhead (FIGS. **1**, **9** and **11-14**). The base may be cast as part of the arm, welded to the arm, or attached by mechanical means. As examples only, the base may be formed and mounted to the cutterhead such as disclosed in U.S. Pat. No. 4,470,210 or U.S. Pat. No. 6,729,052.

In a dredge tooth, wear member **14** is a point provided with a working section **21** in the form of an elongate slender bit and a mounting section **23** that defines a socket **20** to receive nose **18** (FIGS. **1-10**). Point **14** is rotated by the cutterhead such that it engages the ground in generally the same way with each digging pass. As a result, point **14** includes a leading side **25** and a trailing side **27**. Leading side **25** is the side that first engages and leads the penetration of the ground with each rotation of the cutterhead. In the present invention, trailing side **27** has a smaller width than leading side **25** (i.e., along a plane perpendicular to the longitudinal axis **28** of point **14**) through bit **21** (FIG. **5**) and at least partially through mounting section **23** (FIG. **4**). In a preferred embodiment, trailing side **27** has a smaller width than leading side **25** throughout the length of point **14** (FIGS. **4**, **5** and **7**).

Bit **21** of point **14** preferably has a generally trapezoidal transverse configuration with a leading side **25** that is wider than trailing side **27** (FIG. **5**). The term "transverse configuration" is used to refer to the two-dimensional configuration along a plane perpendicular to the longitudinal axis **28** of wear member **14**. On account of this narrowing of the point, sidewalls **29**, **31** follow in the shadow of leading side **25** during digging and thereby create little drag on the cutting operation. In a preferred construction, sidewalls **29**, **31** converge toward trailing side **27** at an angle δ of about 16 degrees

(FIG. **5**); however, other angular configurations are possible. The leading side **25**, trailing side **27** and sidewalls **29**, **31** can be planar, curved or irregular. Moreover, shapes other than trapezoidal can be used that provide side relief.

In use, dredge point **14** penetrates the ground to a certain depth with each digging pass (i.e., with each rotation of the cutterhead). During much of the point's useful life, the bit alone penetrates the ground. As one example, the ground level in one digging cycle extends generally along line **3-3** (FIG. **2**) at the center point of a digging pass. Since only the bit penetrates the ground and the bit is relatively thin, the drag placed on the digging operation is within manageable limits. Nevertheless, with many teeth being constantly driven through the ground at a rapid rate, power requirements are always high and reducing the drag even in the bit is beneficial to the operation, especially when digging through rock.

In a preferred construction, sidewalls **29**, **31** not only converge toward trailing side **27**, but are configured so that the sidewalls lie within the shadow of the leading side **25** in the digging profile. The "digging profile" is used to mean the cross-sectional configuration of the portion of point **14** that penetrates the ground along a plane that is (i) parallel to the direction of travel **34** at the center point of a digging pass through the ground and (ii) laterally perpendicular to the longitudinal axis. The digging profile is a better indication of the drag to be imposed on the point during use than a true transverse cross section. The provision of side relief in the digging profile is dependent on the angle at which the sidewalls converge toward the trailing side and the axial slope or expansion of the point surfaces in a rearward direction. The intention is to provide a width that generally narrows from the leading side to the trailing side when considered from the perspective of the digging profile. Side relief in the digging profile preferably extends across the expected cutterhead digging angles, but benefit can still be obtained if such side relief exists in at least one digging angle. As one example only, the cross-sectional configuration illustrated in FIG. **3** represents one digging profile **35** for a portion of point **14** being driven through the ground. As can be seen, bit **21** is still provided with side relief even in the digging profile as sidewalls **29**, **31** converge toward trailing side **27** for reduced drag.

As bit **21** wears away, the ground level gradually creeps rearward so that more rearward, thicker portions of the point **14** are pushed through the ground with each digging cycle. More power is therefore required to drive the cutterhead as the points wear. Eventually, enough of the bit wears away such that the mounting section **23** of the point **14** is being driven through the ground with each digging pass. In the present invention, the mounting section **23** continues to include side relief at least at the front end **40** of the mounting section (FIG. **4**), and preferably throughout the mounting section (FIGS. **4** and **7**). As seen in FIG. **4**, mounting section **23** is larger than bit **21** to accommodate the receipt of nose **18** into socket **20** and to provide ample strength for the interconnection between point **14** and base **12**. Sidewalls **29**, **31** are inclined so as to converge toward trailing side **27**. The inclination of sidewalls **29**, **31** along line **4-4** is, in this one example, at an angle α of about 26 degrees (FIG. **4**), but other inclinations can also be used. As discussed above, the desired side relief in the digging profile depends on the relation between the transverse inclination of the sidewalls and the axial expansion of the point.

In one conventional point **14***a*, bit **21***a* has a trapezoidal transverse configuration with a leading side **25***a* that is wider than trailing side **27***a*. However, bit **21***a* does not provide side relief in the digging profile. As seen in FIG. **3**A, the digging profile **35***a* (i.e. along line **3**A-**3**A) in FIG. **2**A does not have sidewalls **29***a*, **31***a* that converge toward trailing side **27***a* (FIGS. **2**A and **3**A). Rather, sidewalls **29***a*, **31***a* in digging profile **35***a* expand outward at an increasingly greater slope as the sidewalls extend toward the trailing side. This outward flaring of sidewalls **29***a*, **31***a* will generate an increased drag on the cutterhead. The effective use of side relief in point **14** for the digging profile is a better reduction of drag than simply using sidewalls that convey in a transverse configuration.

In one other example, bit **21** has worn down to an extent where the portion of mounting section **23** along line **6-6** (FIGS. **2** and **6**) is driven through the ground. Even the mounting section **23** provides side relief for reduced drag; i.e., sidewalls **29**, **31** converge toward trailing side even in digging profile **45**. The presence of side relief in digging profile **45** imposes less drag and, hence, requires less power to be driven through the ground. The reduced drag, in turn, enables the cutterhead to continue to operate with points worn to the point where the mounting section penetrates the ground. In conventional point **14***a*, mounting section **23***a* does not have a trapezoidal transverse configuration with sidewalls **29***a*, **31***a* that converge toward trailing side **27***a*. Moreover, as seen in FIG. **6**A, sidewalls **29***a*, **31***a* diverge from leading side **25***a* in digging profile **45***a* taken along line **6***a*-**6***a* encompassing the front end **40***a* of mounting section **23***a*. The lack of side relief in the digging profile imposes a heavy drag on the point **14***a* as it is driven through the ground especially as compared to the present inventive point **14**. With the heavy drag produced by points **14***a* in this condition, many operators will replace the points when the mounting sections **23***a* begin to be driven through the ground even though bits **21***a* are not fully worn out. With the present invention, points **14** can stay on bases **12** until bits **21** are further worn out.

In a preferred construction, the tapering of sidewalls **29**, **31** continues from front end **37** to rear end **47** of point **14**. As seen in FIG. **7**, sidewalls **29**, **31** converge toward trailing side **27** even at the rear of mounting section **23**. Moreover, side relief is provided even in a digging profile **55** along line **8-8** (FIGS. **2** and **8**), i.e., sidewalls **29**, **31** converge toward trailing side **27** even in this rearward digging profile **55**.

The use of a point **14** with side relief in bit **21** and mounting end **23** as described above can be used with virtually any nose and socket configuration. Nonetheless, in one preferred construction, front end **58** of nose **18** includes a forward-facing bearing face **60** that is convex and curved about two perpendicular axes (FIGS. **1**, **9** and **11-14**). Likewise, the front end **62** of socket **20** is formed with a complementary concave and curved bearing face **64** to set against bearing face **60** (FIGS. **1**, **7**, **9** and **11**). In the illustrated construction, front bearing faces **60**, **64** each conforms to a spherical segment to lessen stress in the components due to the application of non-axial loads such as disclosed in U.S. Pat. No. 6,729,052, which is incorporated in its entirety herein by reference.

Preferably, front ends **58**, **62** are each generally hemispherical to reduce the rattle between point **14** and base **12** and more effectively resist loads from all directions. Front bearing surface **64** of socket **20** is preferably slightly broader than hemispherical at its ends and center to accommodate reliably mounting of points **14** on different bases (i.e., without binding or bottoming out), but which under common loads or following wear operate as a true hemispherical socket surface on the hemispherical ball surface of base **12**. In a conventional tooth **10***a* (FIG. **2**A), the point shifts **14***a* around on the nose as the tooth is forced through the ground. The front ends of the socket and nose are angular with flat bearing surfaces and hard corners. During use, point **14***a* shifts around on the nose such that the front of the socket **20***a* rattles around and against the front end of the nose, and the rear end of the socket shifts around and rattles against the rear end of the nose. This shifting and rattling causes the point and base to wear. In the present invention, the use of generally hemispherical front bearing faces **60**, **64** substantially reduces the rattle at the front end of the socket **20** and nose **18** (FIGS. **1** and **9**). Rather, the use of smooth, continuous front bearing faces enables the point to roll about the nose to reduce wear. A small band **65**, substantially parallel to the longitudinal axis **28**, preferably extends directly rearward of the generally hemispherical bearing surfaces to provide additional capacity for the nose to wear and still maintain the desired support. The term "substantially parallel" is intended to include parallel surfaces as well as those that axially diverge rearwardly from axis **28** at a small angle (e.g., of about 1-7 degrees) for manufacturing or other purposes. The small band **65** is preferably axially inclined no more than 5 degrees to axis **28**, and most preferably is axially inclined about 2-3 degrees.

Nose **18** includes a body **66** rearward of front end **58** (FIGS. **11-14**). Body **66** is defined by an upper surface **68**, a lower surface **69** and side surfaces **70**, **71**. In a preferred construction, body surfaces **68-71** diverge rearwardly so that nose **18** expands outward from front end **58** to provide a more robust nose to withstand the rigors of digging. Nevertheless, it is possible for only the upper and lower surfaces **68**, **69** to diverge from each other and for the side surfaces **70**, **71** to axially extend substantially parallel to each other. Socket **20** has a main portion **76** rearward of front end **62** to receive body **66**. Main portion **76** includes an upper wall **78**, lower wall **79** and sidewalls **80**, **81** that conform to body surfaces **68-71**. In a preferred embodiment, body **66** and main portion **76** each have a trapezoidal transverse configuration. The use of a trapezoidal shape predominantly along the length of nose **18** and socket **20** provides four corners **67**, **77**, which act as spaced ridges to resist turning of wear member **14** about axis **28**.

Also, in a preferred embodiment, at least one of the body surfaces **68-71** and socket walls **78-81** (and preferably all of them) have mutually bowed configurations (FIGS. **7**, **11** and **13**); that is, body surfaces **68-71** are preferably concave and curved across substantially their entire widths to define a trough **84** on each of the four sides of body **66**. Likewise, socket walls **78-81** are preferably convex and curved across substantially their entire widths to define projections **86** received into troughs **84**. The preferred bowing of nose surfaces **68-71** and socket walls **78-81** across substantially their entire widths accentuate corners **67**, **77** to provide increased resistance to the rotation of point **14** about base **12** during operation. The troughs and projections will also reduce rotational rattle of the point on the base. While the bowed surfaces **68-71** and walls **78-81** are preferred, other trough and projection configurations such as disclosed in U.S. patent application Ser. No. 11/706,582, which is incorporated herein by reference, could also be used. Other rotation resisting constructions could also be used.

The use of troughs **84** and projections **86**, and particularly those that are gradually curved and extending substantially across the entire widths of the surfaces **68-71** and walls **78-81** eases the assembly of point **14** onto nose **18**; i.e., the troughs **84** and projections **86** cooperatively direct point **14** into the proper assembled position on nose **18** during assembly. For example, if point **14** is initially installed on nose **18** out of proper alignment with the nose as it is fit onto the nose, the engagement of projections **86** being received into the troughs **84** will tend to rotate the point into proper alignment as the point is fed rearward onto nose **18**. This cooperative effect of troughs **84** and projections **86** greatly eases and speeds installation and the setting of corners **67** into corners **77**. Some variations could also be used between the shapes of the socket and the nose so long as the socket predominantly matches the shape of the nose.

Nose surfaces **68-71** with troughs **84** are each preferably inclined axially to expand outward as they extend rearward to provide strength to nose **18** until reaching a rear stabilizing surface **85** of nose **18**. Likewise, socket walls **78-81** with projections **86** also each expand to conform to surfaces **68-71**. Socket walls **78-81** also define rear stabilizing surfaces **95** to bear against stabilizing surfaces **85**. Rear stabilizing surfaces **85**, **95** are substantially parallel to longitudinal axis **28**. In one preferred embodiment, each stabilizing surface **85**, **95** diverges axially rearward at an angle to axis **28** of about 7 degrees. The rear stabilizing surfaces **85**, **95** also preferably encircle (or at least substantially encircle) nose **18** and socket **20** to better resist non-axial loads. While contact between the various socket surfaces and the nose will likely occur during an excavating operation, contact between the corresponding front bearing surfaces **60**, **64** and rear stabilizing surfaces **85**, **95** is intended to provide primary resistance to the applied loads on the tooth and thereby provide the desired stability. While stabilizing surfaces **85**, **95** are preferably formed with short axial extensions, they could have longer or different constructions. Also, in certain circumstances, e.g., in light duty operations, benefits can be achieved without stabilizing surfaces **85**, **95**.

Front bearing faces **60**, **64** and rear stabilizing surfaces **85**, **95** are provided to stabilize the point on the nose and to lessen stress in the components. The generally hemispherical bearing faces **60**, **64** at the front ends **58**, **62** of the nose **18** and socket **20** are able to stably resist axial and non-axial rearward forces in direct opposition to the loads irrespective of their applied directions. This use of curved, continuous front bearing surfaces reduces rattling of the point on the nose and reduces the stress concentrations that otherwise exist when corners are present. Rear stabilizing surfaces **85**, **95** complement the front bearing faces **60**, **64** by reducing the rattle at the rear of the point and providing stable resistance to the rear portions of the point, as described in U.S. Pat. No. 5,709,043 incorporated herein by reference. With stabilizing surfaces **85**, **95** extending about the entire perimeter of nose **18** or at least substantially about the entire perimeter (FIGS. **7**, **9** and **11-14**), they are also able to resist the non-axially directed loads applied in any direction.

Main portion **76** of socket **20** preferably has a generally trapezoidal transverse configuration to receive a matingly shaped nose **18** (FIGS. **7** and **11**). The generally trapezoidal transverse configuration of socket **20** generally follows the generally trapezoidal transverse configuration of the exterior **97** of point **14**. This cooperative shaping of the socket **20** and exterior **97** maximizes the size of the nose **18** that can be accommodated within point **14**, eases the manufacturing of point **14** in a casting process, and enhances the strength to weight ratio.

A wide variety of different locks can be used to releasably secure wear member **14** to base **12**. Nonetheless, in a preferred embodiment, lock **16** is received into an opening **101** in wear member **14**, preferably formed in trailing wall **27** though it could be formed elsewhere (FIGS. **1**, **9** and **15-20**). Opening **101** preferably has an axially elongated shape and includes a front wall **103**, a rear wall **105**, and sidewalls **107**, **109**. A rim **111** is built up around opening **101** for protection of the lock and for additional strength. Rim **111** is also enlarged along rear wall **105** to extend farther outward of exterior surface **97** and define a hole **113** for passage of lock **16**. The hole stabilizes the position of lock **16** and permits easy access to it by the operator.

Nose **18** includes a stop **115** that projects outward from upper side **68** of nose **18** to engage lock **16**. Stop **115** preferably has a rear face **119** with a concave, curved recess **121** into which a front end **123** of lock **16** is received and retained during use, but other arrangements could be used to cooperate with the lock. In a preferred construction, opening **101** is long enough and trailing wall **27** sufficiently inclined to provide clearance for stop **115** when wear member **14** is installed onto nose **18**. Nevertheless, a relief or other forms of clearance could be provided in socket **20** if needed for the passage of stop **115**. Further, the projection of stop **115** is preferably limited by the provision of a depression **118** to accommodate a portion of lock **16**.

Lock **16** is a linear lock oriented generally axially to hold wear member **14** onto base **12**, and to tighten the fit of wear member **14** onto nose **18**. The use of a linear lock oriented axially increases the capacity of the lock to tighten the fit of the wear member on the nose; i.e., it provides for a greater length of take up. In a preferred embodiment, lock **16** includes a threaded shaft **130** having a front end **123** and a rear end with head **134**, a nut **136** threaded to shaft **130**, and a spring **138** (FIGS. **1**, **9** and **15-20**). Spring **138** is preferably formed of a series of elastomeric disks **140** composed of foam, rubber or other resilient material, separated by spacers **142** which are preferably in the form of washers. Multiple disks **140** are used to provide sufficient force, resiliency and take up. The washers isolate the elastomeric disks so that they operate as a series of individual spring members. Washers **142** are preferably composed of plastic but could be made of other materials. Moreover, the spring of the preferred construction is economical to make and assemble on shaft **130**. Nevertheless, other kinds of springs could be used. A thrust washer **142*a*** or other means is preferably provided at the end of the spring to provide ample support.

Shaft **130** extends centrally through spring **138** to engage nut **136**. Front end **123** of shaft **130** fits into recess **121** so that the shaft **130** is set against stop **115** for support. Rear end **134** of lock **16** extends through hole **113** in wear member **14** to enable a user to access the lock outside of opening **101**. The shaft is preferably set at an angle to axis **28** so that head **134** is more easily accessed. Spring **138** sets between rear wall **105** and nut **136** so that it can apply a biasing force to the wear member when the lock is tightened. Hole **113** is preferably larger than head **134** to permit its passage during installation of lock **16** into assembly **10**. Hole **113** could also be formed as an open slot to accommodate insertion of shaft **130** simply from above. Other tool engaging structures could be used in lieu of the illustrated head **134**.

In use, wear member **14** is slid over nose **18** so that nose **18** is fit into socket **20** (FIGS. **1** and **9**). The lock can be temporarily held in hole **113** for shipping, storage and/or installation by a releasable retainer (e.g., a simple twist tie) fit around shaft **130** outside of opening **101** or it can be installed after the wear member is fit onto the nose. In any event, shaft **130** is inserted through hole **113** and its front end **123** set in recess **121** of stop **115**. Lock **16** is positioned to lie along the exterior of nose **18** so that no holes, slots or the like need to be formed in the nose to contain the lock for resisting the loads. Head **134** is engaged and turned by a tool to tighten the lock to a compressive state to hold the wear member; i.e., shaft **130** is turned relative to nut **136** so that front end **123** presses against stop **115**. This movement, in turn, draws nut **136** rearward against spring **138**, which is compressed between nut **136** and rear wall **105**. This tightening of lock **16** pulls wear member **14** tightly onto nose **18** (i.e., with front bearing faces **60**, **64** engaged) for a snug fit and less wear during use. Continued turning of shaft **130** further compresses spring **138**. The compressed spring **138** then urges wear member **14** rearward as the nose and socket begin to wear. The stability of the preferred nose **18** and point **14** enables the use of an axial lock, i.e., no substantial bending forces will be applied to the lock so that the high axial compressive strength of the bolt can be used to hold the wear member to the base. Lock **16** is lightweight, hammerless, easy to manufacture, does not consume much space, and does not require any openings in the nose.

In a preferred construction, lock **16** also includes an indicator **146** fit onto shaft **130** in association with nut **136** (FIGS. **15-20**). Indicator **146** is preferably a plate formed of steel or other rigid material that has side edges **148**, **149** that fit closely to sidewalls **107**, **109** of opening **101**, but not tightly into opening **101**. Indicator **146** includes an opening that fully or partially receives nut **136** to prevent rotation of the nut when shaft **130** is turned. The close receipt of side edges **148**, **149** to sidewalls **107**, **109** prevents indicator **146** from turning. Alternatively, the indicator could have a threaded bore to function as the nut; if the indicator were omitted, other means would be required to hold nut **136** from turning. Indicator **146** could also be discrete from nut **136**.

Indicator **146** provides a visual indication of when shaft **130** has been suitably tightened to apply the desired pressure to the wear member without placing undue stress on shaft **130** and/or spring **138**. In a preferred construction, indicator **146** cooperates with a marker **152** formed along opening **101**, e.g., along rim **111** and/or sidewalls **107**, **109**. Marker **152** is preferably on rim **111** along one or both sidewalls **107**, **109**, but could have other constructions. Marker **146** is preferably a ridge or some structure that is more than mere indicia so that it can be used to retighten lock **16** when wear begins to develop as well as at the time of initial tightening.

When shaft **130** is turned and nut **136** drawn rearward, indicator **146** moves rearward (from the position in FIG. **16**) with nut **136** within opening **101**. When indicator **146** aligns with marker **152** (FIG. **15**), the operator knows that tightening can be stopped. At this position, lock **16** applies a predetermined pressure on wear member **14** irrespective of the wear on the nose and/or in the socket **20**. Hence, both under-tightening and over-tightening of the lock can be easily avoided. As an alternative, indicator **146** can be omitted and shaft **130** tightened to a predetermined amount of torque.

The various aspects of the invention are preferably used together for optimal performance and advantage. Nevertheless, the different aspects can be used individually to provide the benefits they each provide.

The invention claimed is:

1. A wear member for excavating equipment comprising a working section and a mounting section generally aligned along a longitudinal axis, the mounting section including a socket for receiving a base fixed to the excavating equipment, and an opening in communication with the socket for receiving a lock in a generally axial direction to releasably hold the wear member to the excavating equipment, the opening having a front wall and a rear wall, the rear wall defining a surface to maintain the lock in a compressive state, and the rear wall including a hole through which the lock extends from the opening at an inclination to the longitudinal axis for easy access outside of the opening by an operator for tightening of the lock.

2. A wear member in accordance with claim **1** wherein a marker is provided adjacent the opening to provide a visual indicating to the operator when the lock has been sufficiently tightened.

3. A wear member in accordance with claim 1 wherein the socket includes rear stabilizing surfaces axially extending substantially parallel to the longitudinal axis and positioned rearward of the hole.

4. The wear member in accordance with claim 1 wherein the rear wall is generally perpendicular to the extension of the lock.

5. The wear member in accordance with claim 1 wherein the rear wall defines a bearing surface for the lock.

6. A wear member in accordance with claim 1 wherein the opening is in the top of the wear member.

7. A wear assembly for excavating equipment comprising:

a base fixed to the excavating equipment and including a first surface;

a wear member including a working section and a mounting section generally aligned along a longitudinal axis, the mounting section having a socket in which to receive the base, and an opening having a second surface; and

an elongate lock oriented in the same general direction as the longitudinal axis to fit between the first surface and the second surface in a compressive state to releasably hold the wear member to the base, the lock including a first face to contact the first surface on the base and a second face to contact the second surface on the wear member, the first and second surfaces being aligned and facing in opposite directions and the lock being adjustable such that the first and second faces can be moved apart when contacting the first and second surfaces to tighten the fit of the lock between the components and tighten the fit of the wear member onto the base.

8. The wear member in accordance with claim 7 wherein the first and second faces of the lock move apart along an axis inclined to the longitudinal axis.

9. A wear assembly for excavating equipment comprising:

a base fixed to the excavating equipment and including a first surface;

a wear member including a working section and a mounting section generally aligned along a longitudinal axis, the mounting section having a socket in which to receive the base, and an opening having a second surface; and

an elongate lock oriented in the same general direction as the longitudinal axis to fit between the first surface and the second surface in a compressive state to releasably hold the wear member to the base, wherein the lock includes a threaded shaft to bear against the first surface, a nut threaded to the shaft, and a spring about the shaft to be compressed between the second surface and the nut.

10. The wear assembly in accordance with claim 9 wherein the elongate lock is generally parallel to the longitudinal axis in a first plane and inclined to the longitudinal axis in a second transverse plane.

11. A method for installing a wear member onto excavating equipment comprising:

fitting a wear member with a socket over a nose fixed to the excavating equipment such that the nose is received into the socket;

positioning an elongate lock in an opening in the wear member so that a first bearing surface of the lock fits against a bearing surface on the nose, a second bearing surface of the lock fits against a bearing surface on the wear member, and a longitudinal axis of the lock is oriented generally in the direction the wear member is fit over the nose;

adjusting the lock with first bearing surfaces fit against the nose and the second bearing surface fit against the wear member to tighten the fit of the wear member onto the nose so that the lock is in a compressive state to hold the wear member to the base.

12. The method of installing a wear member in accordance with claim 11 wherein the elongate lock is inclined to a longitudinal axis of the wear member.

13. A method for installing a wear member onto excavating equipment comprising:

fitting a wear member with a socket over a nose fixed to the excavating equipment such that the nose is received into the socket, positioning an elongate lock in an opening in the wear member so that a first bearing surface of the lock fits against a bearing surface on the nose, a second bearing surface of the lock fits against a bearing surface on the wear member, and a longitudinal axis of the lock is oriented generally in the direction the wear member is fit over the nose, adjusting the lock to tighten the fit of the wear member onto the nose so that the lock is in a compressive state to hold the wear member to the base, wherein the lock includes a threaded shaft to bear against the first surface, a nut threaded to the shaft, and a spring about the shaft to be compressed between the second surface and the nut.

14. The method of installing a wear member in accordance with claim 13 wherein the elongate lock is positioned at an incline to a longitudinal axis of the wear member.

15. A method for installing a wear member onto excavating equipment comprising:

providing a nose fixed to the excavating equipment having a stop that projects outward from one side thereof;

fitting the wear member with a socket over the nose so that an opening extending through the wear member is placed in general axial alignment with the stop rearward of the stop;

inserting a lock into the opening and in a hole in the wear member to extend out of the opening and outward of the nose, and along an exterior side of the nose, to abut against the stop and a wall of the opening to releasably hold the wear member to the nose.

16. A method in accordance with claim 15 wherein the lock is tightened to be in a compressive state between the stop and the wall of the opening.

17. A method for installing a point onto an adapter secured to excavating equipment comprising fitting the point with a socket defined by a top wall, a bottom wall, and sidewalls over a forwardly projecting nose fixed to the excavating equipment such that the nose is received into the socket, positioning an elongate lock having a threaded shank in an opening in the point such that the lock extends generally axially through the opening so that a front end of the lock fits against a stop on the nose, and a nut threaded to the shank, adjusting the lock to move the nut along the length of the shank in a rearward direction relative to the nose such that the nut abuts a rear wall of the opening and a front bearing face in the socket of the point is tightened against a forward-facing bearing face of the nose.

18. The method for installing a wear member in accordance with claim 17 wherein positioning the lock includes positioning the lock inclined to a longitudinal axis of the wear member.

19. The method for installing a point onto an adapter of claim 17 where the point is tightened onto the nose until a visual indicator of the lock generally aligns with a marker on the point.

20. The method for installing a point onto an adapter of claim 17 where the nut abuts a spring about the shaft and the spring abuts a rear wall of the opening.

21. A wear assembly for excavating equipment comprising:

a base fixed to the excavating equipment and including a stop;

a wear member including a working section and a mounting section generally aligned along a longitudinal axis, the mounting section including a socket for receiving the base fixed to the excavating equipment, and an opening rearward of the stop in communication with the socket for receiving a lock to releasably hold the wear member to the excavating equipment, the opening having a front wall and a rear wall, and the rear wall including a hole; and

a lock which abuts the stop and extends through the hole at an inclination to the longitudinal axis for easy access by an operator for tightening of the lock.

22. A wear assembly for excavating equipment comprising:

a base fixed to the excavating equipment and a wear member received over a portion of the base, the portion of the base received within the wear member including a laterally-outward projecting stop and being substantially solid throughout, the wear member including an opening having a rear wall; and

a lock extending rearward and inclined to the longitudinal axis, the lock including a threaded shank with a front end to contact the stop and a nut that applies a biasing force on the rear wall of the opening to releasably hold the wear member to the base.

23. A wear assembly comprising:

a wear member with a front working portion, a socket at the rear and an opening in the wear member in communication with the socket including a front edge and a rear bearing surface;

a base configured to receive the socket of the wear member aligned along a longitudinal axis, the base including a front bearing surface; and

a lock including a front end and a rear end to engage the front bearing surface and the rear bearing surface;

where with the lock positioned in the opening and in a compressive state biases the lock front end against the front bearing surface of the base and the lock rear end against the rear bearing surface of the wear member to secure the wear member to the base.

24. The wear assembly of claim 23 where the rear bearing surface of the opening is spaced farther from the longitudinal axis than the front edge of the opening.

25. The wear assembly of claim 23 where the lock rear end is spaced farther from the longitudinal axis than the lock front end with the lock engaging the front bearing surface and the rear bearing surface.

26. The wear assembly of claim 23 where the front bearing surface includes a recess that accepts at least a portion of the lock front end.

27. The wear assembly of claim 23 where the lock bias between the front bearing surface and the rear bearing surface urges the wear member rearward onto the base and to take up gaps between the wear member and the base.

28. The wear assembly of claim 23 where the base is free of through holes.

29. The wear assembly of claim 23 where the front bearing surface is accessible through the opening of the wear member with the wear member assembled to the base.

30. The wear assembly of claim 23 where the lock includes a spring biasing member.

31. The wear assembly of claim 23 where the lock in the opening accepts a tool to tighten the lock and the tool rotates at least a portion of the lock to tighten the lock.

32. The wear assembly of claim 31 where the lock includes a visual indictor of rotation of the lock.

33. The wear assembly of claim 31 where the visual indicator determines the pressure exerted by the lock.

34. A wear member for excavating equipment comprising a working section and a mounting section generally aligned along a longitudinal axis, the mounting section including a socket for receiving a base fixed to the excavating equipment, and an opening in communication with the socket for receiving a lock in a generally axial direction to releasably hold the wear member to the excavating equipment, the opening having a front wall and a rear wall, and the rear wall including a hole through which the lock extends from the opening at an inclination to the longitudinal axis so that the lock abuts a stop on the nose within the socket and for easy access outside of the opening by an operator for tightening of the lock.

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